

# Bothalia

A RECORD OF

## CONTRIBUTIONS

FROM THE

### NATIONAL HERBARIUM

UNION OF SOUTH AFRICA

PRETORIA



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# GASTEROMYCETES OF SOUTH AFRICA.

BY A. M. BOTTOMLEY.

The following account of the Gasteromycetes in South Africa is the outcome of an early interest in the Geasters. Available literature on the subject was at that time scanty and not easily accessible to the average person interested in these quaint plants, which formerly occurred very commonly in and around Pretoria. The original intention was simply to publish a more or less popular note on these fungi for such people, but as time went on and more data were spasmodically accumulated on these and related plants, it was finally decided to write up an account of all the Gasteromycetes even if imperfectly known. This decision was influenced by the fact that no comprehensive work on this group had been written since 1925, when Verwoerd published his "Suid-Afrikaanse Lycoperdaceae en Nidulariaceae" in Volume III of the *Annale van die Universiteit van Stellenbosch*. The present publication is not in any sense a critical revision of the Gasteromycetes; it is merely an assembling of all the known records of these fungi in Southern Africa. The author is fully aware of its many defects, but it is hoped that it will form a basis for more critical work by those coming after and will fill a long felt want for something fuller, and more comprehensive than papers previously published in this country.

The Gasteromycetes, probably on account of their size and often strange appearance, attracted the attention of many of the early travellers and botanists, who frequently included specimens of these fungi—more as curiosities than anything else—in general botanical collections, which they sent to European herbaria for identification. Unfortunately, however, such collections often consisted of a single specimen, or, on account of their fragile nature, arrived in a damaged condition. As a result it is sometimes difficult to link up later collections with the old specimens, especially as descriptions in the early days were usually inadequate and illustrations, if any, sometimes rather crude and diagrammatic. These early collectors were extremely lucky in their discoveries, including as they did, some of our most uncommon and interesting fungi. One of the first Gasteromycetes recorded for South Africa was the plant now called *Podaxis pistillaris* (L. ex Pers.) Morse—long known as *Podaxon carcinomalis* (L.) fr.—collected by Thunberg on anthills and originally described by Linnaeus in 1781 as *Lycoperdon carcinomalis*. The next discovery of note was that of *Secotium Gueinzii* Kze. found by Gueinzius in sandy soil in the Cape Peninsula and a few months later by Zeyher at Uitenhage. This fungus has not since been found in the latter locality and only infrequently in the original site and is not known from anywhere else. In 1843 Burke and Zeyher discovered *Polyplodium inquinans* Berk. on the banks of the Orange River; it was not rediscovered for eighty years when Pole Evans found it in 1919 growing out of an anthill at Vryburg. A year after this find, Backhouse came across *Broomeia congregata* Berk., which, as far as is known, is endemic in South Africa. Nothing uncommon was collected during the next twenty years but with the arrival of MacOwan at the Cape in 1861 and Medley Wood in Natal, many new species of fungi, including numerous Gasteromycetes, were collected. MacOwan's most important finds in this field were probably *Kalchbrennera corallocephala* (Welw. and Curr.) Kalchbr. and *Macowanites agaricinus* Kalchbr., both rare fungi, the latter not having been found since the original collection. Among Medley Wood's more interesting collections were some of the phalloids such as *Lysurus Gardneri* Berk., originally described by MacOwan as *L. Woodii*, *Kalchbrennera corallocephala* and *Dictyophora indusiata*. Neither MacOwan nor Medley Wood was a mycologist and the custom of their predecessors of sending specimens overseas for identification was continued, with this difference, that duplicate specimens were retained in the country and these formed the nucleus of the first mycological herbaria in South Africa. In the work of identification they received the ready co-operation of such well-known mycologists as Berkeley, Kalchbrenner, Cooke, Montagne, van Thümen and Winter. It was not until the appointment of Dr. I. B. Pole Evans, in 1905, as Mycologist to the

Transvaal, that any mycological work was done in the country, or that a serious attempt was made to build up a fungus herbarium. In addition to the mycological staff attached to the Department of Agriculture, collectors of Gasteromycetes include in particular:—Dr. A. V. Duthie, who collected extensively round Knysna and Stellenbosch; Miss E. L. Stephens, who confined her activities to the rich fields of the Western Cape Province; Professor N. J. G. Smith, who is particularly interested in the Geasters of the Eastern Cape areas; and Mr. J. P. H. Acocks and Mr. Gideon Joubert, who have enriched our collections with a number of rare species.

The Gasteromycetes in the Cryptogamic Herbarium of the Division of Botany and Plant Pathology, Department of Agriculture, Pretoria, form the basis of the present work, but as many specimens as possible from other South African herbaria have been examined. In this connection visits have been paid to the South African Museum in Cape Town, where many of MacOwan's specimens are deposited; to the Cape Town University, where Miss E. L. Stephens has built up an excellent mycological museum; and to the Stellenbosch University, where the van der Byl collections are housed. The Southern Rhodesia Department of Agriculture very kindly sent me their Gasteromycete collection on loan. Owing largely to difficulties caused by the war it has not been possible to examine specimens in overseas herbaria.

In the particulars given for individual specimens, the name and number of the collector are printed in italics; duplicate specimens are placed in brackets, accompanied by an abbreviation of the name of the herbarium in which they are to be found, while the Pretoria numbers are unbracketed. Dates of collections have been recorded to assist collectors in knowing when specific fungi may be expected to appear, since, especially in the case of plants with a short fruiting season, they occur at different times in different parts of the country depending, for the most part, on the rainfall. The appearance of many of the Gasteromycetes in South Africa is very sporadic, some occurring only in exceptionally wet seasons. The following abbreviations have been used to indicate the herbaria in which duplicate and other specimens may be found:—

Alb. Mus.....	Albany Museum, Grahamstown.
E.L.S.....	E. L. Stephens, Cape Town University.
Lloyd Myc. Coll.	Lloyd Mycological Collections, Washington, U.S.A.
N.H.....	Natal Herbarium, Durban.
N.J.G.Sm.....	N. J. G. Smith, Albany Museum, Grahamstown.
S.R.....	Southern Rhodesia, Department of Agriculture, Salisbury.
S.A.M.....	South African Museum, Cape Town.
Stell.....	Stellenbosch University Herbarium, Stellenbosch.
T.R.L.....	Timber Research Laboratory, Chamber of Mines, Johannesburg.
v.d. Byl.....	van der Bijl Herbarium, University of Stellenbosch.
Wit. Herb.....	Witwatersrand University Herbarium, Johannesburg.

As far as possible descriptions have been made from actual specimens, but where such were unsuitable or lacking, these have been augmented or taken over from well known publications such as "Gasteromycetes of Australia and New Zealand" by G. H. Cunningham, "The Gasteromycetes of the United States and Canada" by Coker and Couch, "Gasteromycetes Ungariae" by Hollós and "British Basidiomycetes" by Carleton Rea. Lloyd's Mycological Writings have been consulted mainly for their excellent photographs while Verwoerd's "Suid-Afrikaanse Lycoperdaceae en Nidulariaceae" has been referred to especially for descriptions of new South African species.

Literature references have for convenience been given throughout the text. In addition to the full reference to the original description, references in accepted abbreviated form have been given to the more recent works in which the fungi concerned have been discussed or more fully described and which are more likely to be available for consultation than the older publications.

Colours in the Gasteromycetes are often difficult to match in colour charts but where this has been done, those of Ridgway have been used, such names being prefaced by capital letters and usually put in brackets.

Lacto-phenol has been used as a mountant for microscopic examinations. Spores have, in addition, been examined dry in which condition surface markings are often more clearly defined.

The system of classification followed is that of G. H. Cunningham as outlined in his "Gasteromycetes of Australia and New Zealand", published in 1944. This is the most recent comprehensive account of these fungi, being the result of many years of critical study of the group in all its aspects, developmental as well as morphological. Not only have the principles of his general classification been adopted, but many of his keys to the genera and species have been used, especially in cases where the fungi under discussion are poorly represented in South Africa and consequently imperfectly known.

I would like to express my gratitude to the following for assistance given in the preparation of this paper:—In particular to Dr. E. M. Doidge for many helpful suggestions, for records of early collections and for practical help, without which it would have been difficult, under present conditions, to get the paper ready for publication—to Miss E. L. Stephens for placing her collections at my disposal and for her untiring energy in obtaining Cape specimens and relative data—to Mr. H. A. V. King for his excellent photographic work often rendered difficult by lack of suitable material due to wartime shortages—to Miss E. M. Wakefield for suggestions and identifications of specimens, and to Mr. P. D. B. Talbot for the comparison of specimens in Kew herbarium. Thanks are also due to Dr. Barnard, Director of the South African Museum and to Miss G. J. Lewis for their courtesy in giving me access to the herbarium at that institution, and to Dr. Nel, Professor of Botany at Stellenbosch University and his assistant Miss P. de Vos for the same courtesy in connection with the van der Byl collections—to the Southern Rhodesia Department of Agriculture for the loan of its Gasteromycete collections—to Professor Lutjeharms for the loan of phalloid literature and to the many others, especially in the Division of Botany and Plant Pathology, who have been of assistance in one way or another.

## GLOSSARY OF TERMS.

Acuminate.....	gradually narrowed to a point.
Adnate.....	closely attached.
Allantoid.....	(of spores) sausage-shaped.
Alveolate.....	marked with honeycomb-like hollows.
Anastomose.....	to run together forming a net-work.
Annular.....	ring-like.
Apiculus.....	a short projection at one end of a spore.
Apophysis.....	(of Geasters) a ring-like swelling at the base of the endoperidium.
Appressed.....	close flattened against the surface.
Areolate.....	marked out in small areas.
Asperate.....	rough with small points or granules.
Asperulate.....	diminutive of <i>asperate</i> .
Basidium.....	the spore-producing organ in the Basidiomycetes.
Byssoid.....	cottony; made up of fine threads.
Caducous.....	falling off early.
Caespitose.....	crowded in dense clusters.
Campanulate.....	bell-shaped.
Capillitium.....	a mass of sterile thread-like tubes or fibres mixed with the spores.
Cartilaginous.....	firm and tough but readily bent.
Cinereous.....	ashy-grey or drab-grey.
Circumscissile.....	opening or cracking along a circle.
Citriform.....	lemon-shaped.
Clathrate.....	latticed; like a net-work.
Clavate.....	club-shaped.
Columella.....	a sterile central axis within a mature fruit body.
Conical.....	cone-shaped.
Connivent.....	contacting but not organically united.
Continuous.....	(of capillitium) non-septate; (of spores) one-celled.
Coriaceous.....	leathery in texture.
Crenulate.....	having the edge delicately toothed with rounded teeth.
Cupulate.....	cup-shaped.
Cyathiform.....	like a cup with a flared edge.
Cystidia.....	sterile cells, usually large and hyaline, projecting from the hymenium in many Basidiomycetes; rare in Gasteromycetes.
Daedaloid.....	with elongate and sinuous mouths as in <i>Daedalea</i> .
Definite.....	(of a stoma, pore, mouth) with margin clearly defined.
Dehiscence.....	mode of opening at maturity for the discharge of spores.
Deliquesce.....	to liquefy at maturity.
Dendroid.....	tree-like in form, c.f. the columella in <i>Gymnopogon</i> .
Diaphragm.....	a membrane separating the gleba from the sterile base in some species of <i>Calvatia</i> and <i>Lycoperdon</i> .
Dichotomous.....	repeatedly forking into two more or less equal arms.
Duct.....	elongated cell.
Echinate.....	with sharp pointed spines.
Echinulate.....	with minute and finely pointed spines.
Elaters.....	bodies with spiral or annular markings in the gleba of <i>Batrea</i> .
Elliptical, Elliptic.....	oblong with rounded ends.
Endoperidium.....	the inner layer of the wall which in the Gasteromycetes encloses the gleba.
Epigaeous, Epigean.....	growing on the surface of the ground.
Epiphramgm.....	the thin membrane covering the mouth of the young fruit body in the Nidulariaceae.
Episporule.....	the outer wall of the spore.
Evanescing.....	soon disappearing.
Exoperidium.....	outermost layer of the wall which in the Gasteromycetes encloses the gleba.
Exospore.....	a gelatinous membrane covering the episporule.
Farinose.....	covered with mealy particles.
Fasciculate.....	applied to the persistent fascicles of basidia in <i>Podaxis</i> and <i>Phellorina</i> .
Ferruginous.....	rusty brown.
Fibril.....	a very small fibre.
Fibrillose.....	(of a stoma) enclosed within a zone of silky, parallel fibrils arranged radially.

Filiform.....	thread-like.
Fimbriate.....	fringed.
Fissured.....	split.
Fistulose.....	tubular, hollow.
Floccose, Flocculent.....	delicately cottony.
Fornicate.....	(of the Geastraceae) arched; applied to species in which the fibrous and fleshy layers split from the mycelial layer—which remains as a cup on the ground—and become arched above it.
Fragment.....	break in pieces.
Fugacious.....	soon disappearing.
Fulvous.....	reddish cinnamon brown; tawny.
Funiculus.....	(of Nidulariaceae) the cord of hyphae by which the peridioles are at first fixed to the peridium.
Furfuraceous.....	scurfy; covered with bran-like particles.
Fuscous.....	smoky drab; dusky.
Fusiform.....	thick in the centre and tapering to a point at each end.
Glabrous.....	smooth, free from hairs, scales, etc.
Gleba.....	the spore mass enclosed within the peridium, composed of cavities lined with the hymenium.
Gregarious.....	growing in groups.
Guttule.....	(in spores) oil globule.
Hyaline.....	colourless and transparent or nearly so.
Hygroscopic.....	readily absorbing moisture from the air.
Hymenium.....	the spore-bearing layer lining the cavities formed by the tramal plates; commonly composed of a palisade of basidia.
Hypogeous.....	growing below the surface of the ground.
Imbricate.....	overlapping one another like the tiles on a roof.
Indefinite.....	applied to a stoma which is not delimited by a definite tissue; it appears merely as an aperture.
Indehiscent.....	applied to plants with no special method of opening.
Indigenous.....	native to a country.
Indusium.....	a membrane in <i>Dictyophora</i> which hangs from the apex of the stipe beneath the pileus.
Involute.....	with margins rolled inwards.
Labyrinthiform.....	tortuous, like a labyrinth.
Laciniate.....	cut or torn into lobes.
Lactiferous ducts.....	ducts having a milk-like juice.
Lacunose.....	covered with pits or indentations.
Lamellate.....	made up of thin plates.
Laminated.....	consisting of plates or layers.
Lanceolate.....	many times longer than broad and tapering.
Lenticular.....	shaped like a double convex lens.
Mammose.....	with breast-like protuberances.
MM.....	millimetre, approximately 1/25 of an inch.
Micron.....	1/1000 of an inch, indicated by the Greek $\mu$ .
Monosporous.....	bearing one spore.
Mouth.....	(of a peridium) the stoma or pore through which spores are discharged.
Mycelium.....	a mass of hyphae.
Naked.....	applied to a stoma (mouth, pore) which is not enclosed within a peristome.
Nomen conservandum.....	name conserved by the International Botanical Congress.
Obconic.....	with the appearance of a cone held upside down.
Obovate.....	egg-shaped, with the broader end uppermost.
Ochraceous.....	ochre-yellowish.
Olivaceous.....	with an olive tint; yellowish olive.
Organically united.....	applied to tissues which fuse together so as to form one completely united structure.
Ovate, Ovoid.....	egg-shaped, with the broader end at the base.
Palisade.....	applied to elongated cells arranged close together in parallel fashion.
Papillate.....	with the surface provided with small rounded processes.

## GLOSSARY.

Papyraceous.....	papery, resembling parchment.
Pedicel.....	a small stalk.
Pedicellate.....	borne on a pedicel.
Percurrent.....	extended through the entire length.
Peridiole.....	(of the Nidulariales) a body containing spores and enclosed within the peridium.
Peridium.....	a wall or membrane enclosing the fruit body.
Peristome.....	an edging round an opening, e.g. stoma, mouth of endoperidium.
Phalloid.....	resembling the genus <i>Phallus</i> .
Pileate.....	having a pileus or cap.
Pitted.....	with small depressions.
Plane.....	(of a stoma) flat, not projecting above the surface.
Plicate.....	(of the peristome) pleated.
Polygonal.....	many angled.
Pore.....	an opening in the endoperidium to allow for the discharge of spores.
Prosenchymatous.....	consisting of long cells or filaments.
Pruinose.....	having a frost-like or powdered surface covering.
Pseudoparenchyma.....	looking like true parenchyma but formed of hyphae.
Pubescent.....	having soft hairs.
Pulverulent.....	powdery.
Pulvinate.....	cushion-shaped.
Punctate.....	marked with very small spots or depressions.
Punky.....	soft and tough; corky.
Pyriform.....	pear-shaped.
Radicate.....	rooting.
Receptacle.....	(of the Phallaceae) the stem-like or clathrate structure on which the spore masses are borne.
Recurved.....	curved backwards and downwards.
Reticulated.....	with net-like, raised markings.
Revolute.....	rolled back from the apex.
Rhizomorph.....	a thread- or cord-like structure formed of compacted hyphae.
Rimose.....	cracked.
Rugose.....	wrinkled.
Rugulose.....	delicately wrinkled.
Saccate.....	like a sac or bag.
Scabrous.....	rough with fine projections.
Scissile.....	splitting.
Septa.....	cell walls or divisions.
Septate.....	having dividing walls.
Sculpturing.....	applied to the various surface markings of spores.
Sessile.....	without stem, sterigma or pedicel.
Simple.....	(of the capillitium) with unbranched threads.
Sinuous.....	wavy.
Spicule.....	a small, erect point.
Spinulose.....	with small spines.
Squamule.....	a small scale.
Sterigma.....	a slender process by which a spore is attached to the basidium.
Sterile base.....	applied to the non-spore-bearing tissue at the base of the spore mass.
Stipitate.....	stalked.
Stoma.....	an opening in the endoperidium through which spores are discharged.
Striate.....	marked with delicate lines, grooves or ridges.
Stroma.....	(of <i>Broomeia</i> ) a compact mass of vegetative hyphae in which the fruiting bodies are partly embedded.
Strigose.....	rough with sharp-pointed, stiff hairs.
Subclavate.....	not quite club-shaped.
Subcoriaceous.....	approaching leathery in texture.
Subcicum.....	a felted growth of mycelium on which fruiting bodies are borne.
Substratum.....	the material on or in which a saprophyte lives.
Sulcate.....	fluted or grooved.
Synonym.....	another name for a species, especially a later or invalid name.
Tomentose.....	having a covering of soft hairs.
Tramal Plates.....	the plates of the gleba which carry the hymenium.
Truncate.....	abruptly cut off.
Tuberular.....	having small, wart-like processes.
Tuberiform.....	tuber-shaped.

Tunica.....	(of Nidulariaceae) a thin white membrane covering the peridiole ; (of spores
Turbinate.....	a gelatinous membrane covering the episore. top-shaped.
Umbilicate.....	with a central navel-like depression.
Umbo.....	a boss or raised central swelling.
Umbonate.....	with a boss or umbo.
Urceolate.....	pitcher-like in shape.
Utricle.....	a bladder-like covering or appendage.
Veil.....	see indusium.
Velutinate.....	like velvet due to a covering of fine, soft hairs.
Verrucose.....	having small rounded processes or warts.
Verruculose.....	diminutive of verrucose.
Vesicle.....	a bladder-like sac.
Volva.....	a cup-like structure round the base of a mature stipe or receptacle—the lower part of the universal veil which covers the young fructification.
Wing.....	(of <i>Polyplodium</i> and <i>Gyrophragmium</i> ) a minute membranous expansion of the trama plates.

## GASTEROMYCETES.

## Key to the Orders.

Plants usually hypogeous and sessile. Gleba compact and firm, of tramal plates which are sometimes separate but usually anastomose to form cavities lined with the hymenium. Capillitium wanting..... I. HYMENOGASTRALES.

Plants epigeous, usually of bright colours, bizarre shapes and with an offensive odour. Gleba mucilaginous, usually exposed at maturity, borne on a specialised, pseudo-parenchymatous, spongy, brittle receptacle arising from the base of a cup-shaped volva. Capillitium wanting..... II. PHALLALES.

Plants epigeous, sessile or borne on a pseudo-stem. Gleba enclosed in a peridium, consisting of cellular tissue with cavities lined by a poorly developed hymenium, finally breaking down into a mass of pulverulent spores. Capillitium wanting.. III. SCLERODERMALES.

Plants epigeous, sessile or with well-developed stem. Gleba enclosed in a peridium, breaking down at maturity into a mass of powdery spores which are mixed with well-developed capillitium consisting of simple or branched threads..... IV. LYCOPERDALES.

Plants epigeous, sessile or nearly so, cupulate or depressed-globose. Gleba enclosed in peridiola, borne with dehiscent peridia. Capillitium wanting..... V. NIDULARIALES.

## Key to the Families and Genera.

## Order 1.—HYMENOGASTRALES.

Family 1.—**HYMENOGASTRACEAE**.—Peridium sessile, attached to substratum by one or several basal and/or lateral rhizomorphs.

Sub-family *HYMENOGASTROIDEAE*.—Gleba cellular, without a branched columella.

Peridium attached by lateral rhizomorphs.

Spores elliptical and smooth.

Spores hyaline or tinted only.....

Spores dark coloured.....

Spores globose and verrucose.....

Peridium attached by basal rhizomorphs.

Spores elliptical.....

Spores globose.....

Spores many angled.....

1. **Rhizopogon**.

2. **Melanogaster**.

3. **Sclerogaster**.

4. **Hymenogaster**.

5. **Octaviania**.

(*Richoniella*).

Sub-family *HYSTERANGIOIDEAE*.—Gleba cellular, traversed by a simple or branched columella.

Spores globose, echinulate.....

Spores elliptical.

Spores smooth.....

Spores areolate or verrucose.....

Spores longitudinally ribbed.....

6. **Hydnangium**.

(*Hysterangium*).

7. **Gymnoglossum**.

(*Gautieria*).

Family 2.—**SECOTIACEAE**.—Peridium stipitate, stem traversing the gleba as a simple, well-defined columella.

Tramal plates sparingly to frequently anastomosed to form cavities lined with hymenium.

Gleba entirely covered by the peridium.....

Gleba partially covered by the peridium.....

Tramal plates separate, vertically suspended from apex of peridium, exposed at maturity.

Plants massive, with large volva at base of columella.....

Plants slender, with small volva-like structure at base of stem....

1. **Secotium**.

2. **Macowanites**.

3. **Polypodium**.

4. **Gyrophragmium**.

## Order II.—PHALLALES.

Family 1.—**CLAUSTULACEAE**.—Receptacle on obovate hollow sphere enclosing the spore mass.

Characters of the family.....

(*Claustula*).

Family 2.—**PHALLACEAE**.—Receptacle a simple, hollow, cylindrical stem, the spore mass borne directly on the apical portion or on a campanulate pileus attached to the apex.

Spore mass borne directly on the upper part of the receptacle.

Spore mass covering the apical portion of the receptacle.....

Spore mass forming a collar-like restriction below the inflated apex of the receptacle.....

Spore mass covering a net-like pileus loosely attached to the upper part of the receptacle.....

Spore mass borne on a campanulate pileus.

Indusium absent or rudimentary.

Pileus formed of radiate plates.....

Pileus formed of lamellate plates.....

Pileus externally rugulose, papillate or reticulate.....

Indusium present, well developed.....

1. **Mutinus**.

(*Staheliomyces*).

(*Floccomutinus*).

(*Aporophallus*).

2. **Itajahya**.

3. **Phallus**.

4. **Dictyophora**.

## Order III.—SCLERODERMALES.

Family 1.—**CALOSTOMATACEAE.**—Peridium borne on a prominent pseudo-stem, 3-layered, dehiscing by an apical stoma. Spore mass at maturity within the endoperidium which becomes attached to the apex of the peridium.

Characters of the family ..... (Calostoma).

Family 2.—**SCLERODERMATACEAE.**—Peridium sessile or borne on a pseudo-stem, 1-2-layered, dehiscing by irregular fissuring of the apex. Spores at maturity a powdery mass which is free within the peridium or within small chambers formed by persistent gelatinous trama walls.

Spores free within the peridium ..... 1. **Sclerodermia.**

Spores free within small chambers formed by persistent trama walls.. 2. **Pisolithus.**

Family 3.—**ARACHNIACEAE.**—Peridium sessile, 1-layered, dehiscing by disintegration at maturity into a granular mass consisting of minute, separate, hollow peridioles formed of persistent trama plates lined with hymenium to which the spores are attached.

Characters of the family ..... **Arachnion.**

## Order IV.—LYCOPERDALES.

Family 1.—**LYCOPERDACEAE.**—Peridium sessile or carried upon a pseudo-stem, a true stem being absent.

A.—*Mesophelliae*.—Peridium indehiscent, of two or three layers; capillitium unbranched. Spores globose or elliptical, usually with a gelatinous exospore which may appear warty or reticulated.

Spores elliptical, smooth or irregularly roughened.

Gleba with a central core.....

Gleba without a central core.....

Spores globose, reticulated..... (Mesophellia).

(Castoreum).

(Abstoma).

B.—*Lycoperdeae*.—Peridium 1-2-layered, dehiscing by an apical pore or by irregular rupture of the apex. Capillitium simple or freely branched. Spores typically globose and verrucose.

Plants usually few, single or caespitose.

Capillitium threads more or less smooth, simple or sparingly branched.

Plants dehiscing by an apical pore.

Capillitium threads long, simple or sparingly branched, attached to the endoperidial wall.....

Capillitium threads simple or branched, free within the peridium .....

Plants dehiscing by rupture or disintegration of the apex.

Capillitium pulverulent or compact. Sterile base usually present. Endoperidium usually thick and tough...

Capillitium compact. Sterile base lacking. Endoperidium thin, papery, brittle. Plants becoming detached at maturity.....

1. **Lycoperdon.**

2. **Discidea.**

3. **Calvatia.**

4. **Lanopila.**

5. **Bovista.**

6. **Mycenastrum.**

Capillitium threads freely branched, consisting of a thick stem with sharp pointed, tapering, thinner branches.....

Capillitium threads short, spiny, free within the peridium. Endoperidial wall thick and corky.....

Plants numerous, borne on a common stroma, whole cluster originally covered by an universal exoperidium.

Peridia separated from one another by alveolar walls..

7. **Broomeia.**

Peridia separated from one another by the cuplike remains of individual exoperidia which originally covered them.....

*C.*—*Geastraceae*.—Peridium of 4 layers. Exoperidium splits into segments in stellate manner. Endoperidium dehisces by one or more pores or by rupture of the apex. Capillitium threads simple or branched. Spores typically globose and verrucose to echinulate.

Dehiscence by a single apical pore..... 8. **Geastrum**.

Dehiscence by several apical pores..... 9. **Myriostoma**.

Dehiscence by rupture of the endoperidium..... 10. **Geasteropsis**.

Family 2.—**TULOSTOMATACEAE**.—Peridium borne on a well-developed stem, which in *Podaxis* traverses the gleba as a columella.

Sub-family *TULOSTOMOIDEAE*.—Basidia not in fascicles, disappearing at maturity.

*A.*—*Tulostomeae*.—Elaters not present in the gleba.

Peridium dehiscing by a definite apical pore.....

Peridium dehiscing by irregular fissuring of the apex.....

*B.*—*Batarreae*.—Elaters present in the gleba.

Peridium dehiscing by circumscissile cleavage of the apical portion.. 2. **Batarrea**.

Sub-family *PODAXONOIDEAE*.—Basidia in fasciculate clusters, persisting at maturity.

*C.*—*Phellorineae*.—Peridium seated on the expanded apex of the stem.

Peridium continuous with the stem.....

Peridium not continuous with the stem.

Peridium dehiscing by a definite stoma, gleba pulverulent.....

Peridium dehiscing by irregular breaking away of the apical part ; gleba coarsely chambered.....

*D.*—*Podaxineae*.—Peridium carried at the apex of a stem which traverses the gleba as an axile columella ; dehiscing by longitudinal splitting.

Characters as above.....

### Order V.—NIDULARIALES.

Family 1.—**NIDULARIACEAE**.—Peridioles many, embedded in mucilage within the peridium or attached to the peridial wall by funiculi.

Peridioles attached to the cups by funiculi.

Peridium 1-layered.....

Peridium 3-layered.....

Peridioles without funiculi.

Peridium cup-shaped, with an epiphram.....

Peridium subglobose, without a typical epiphram.....

1. **Crucibulum**.

2. **Cyathus**.

(*Nidula*).  
(*Nidularia*).

Family 2.—**SPHAEROBOLACEAE**.—Peridioles solitary, forcibly discharged from the peridium at maturity.

Characters of the family.....

3. **Sphaerobolus**.

## HYMENOGASTRALES.

Plants epigeous or hypogeous, indehiscent, sessile or stipitate, usually attached to the substratum by one or several rhizomorphs. Peridium 1-3 layered, sometimes disappearing at maturity. Gleba compact and firm, composed of tramal plates anastomosed to form numerous cavities which may be subglobose, elliptical, triangular or labyrinthiform. Traversed or not by a percurrent or branched columella. Tramal plates fleshy, cartilaginous or sometimes gelatinised, formed of pseudoparenchyma or interwoven hyphae. Basidia continuous with the tramal plates, usually forming a compact palisade hymenium lining the cavities, cylindrical or subclavate, permanent or soon breaking up, 2-8-spored. Spores borne on long or short sterigmata, globose or elliptical, smooth or rough, hyaline or coloured.

The characters which distinguish this order from others are the compact, indehiscent gleba, the tramal plates which anastomose to enclose cavities lined with the hymenium and the absence of capillitium threads.

The order contains two families, HYMENOGASTRACEAE and SECOTIACEAE, which are separated from each other mainly on the presence or absence of a stem and the texture of the mature plant. In the Hymenogastraceae the plants are sessile, partly or entirely hypogeous and fleshy or gelatinous at maturity; members of the Secotiaceae are stipitate, the stem being continued through the gleba to the apex of the peridium as a columella, partly or entirely epigeous and usually woody when mature.

## HYMENOGASTRACEAE de Toni

in Saccardo, Sylloge Fungorum 7 (1888) 154.

Zeller and Dodge, Ann. Miss. Bot. Gard. 5 (1918) 1.

Coker and Couch, Gastero (1928) 15.

Ed. Fischer, Naturlichen Pflanzenfamilien 2, 7a (1933) 9.

G. H. Cunningham, Gasteromycetes of Australia and New Zealand (1944) 42.

*Hysterangiaceae* Fischer, Nat. Pflanzenfam. 1\*\* 1 (1900) 304.

*Rhizopogonaceae* Dodge, Comp. Morph. Fungi (1928) 468.

*Hydnangiaceae* Dodge, l.c. p. 485.

*Melanogastraceae* Fischer, Nat. Pflanz. 7a (1933) 9.

Plants hypogeous or epigeous, subglobose, depressed globose, obovate or tuberiform attached to the substratum by basal or lateral rhizomorphs. No true stem present. Indehiscent, disintegrating into a slimy mass at maturity. Peridium 1-2 layered. Gleba of fleshy or gelatinised tramal plates anastomosed to form subglobose, elliptical or labyrinthiform cavities lined with the hymenial layer and at maturity partly or completely filled with spores. Basidia subclavate or cylindrical, 1-8-spored. Sterigmata short or long. Spores globose or elliptical, smooth or rough, hyaline or coloured.

About 45 genera have been described for this family, but of these only seven have so far been recorded for Southern Africa, though it is very probable that a systematic search for these plants would lead to the discovery of others. With the exception of *Rhizopogon*, the individual species are likewise very poorly represented, occurring in only a few widely separated areas. Up to the present they have only been found in the coastal areas of the Cape Province, in Natal and in Southern Rhodesia—none in the Transvaal Province where the present work is being conducted. With only a few dried or formalin-preserved specimens available for examination and no overseas material for comparison, it has been impossible to study this family more than very imperfectly. G.H. Cunningham, l.c., Ed. Fischer, l.c., Zeller and Dodge, l.c. and Coker and Couch, l.c., have been the main sources of reference in studying this group, the classification and keys of the first-mentioned having been selected as most suitable for use with specimens in this country.

## Key to the Genera.

**Hymenogastroideae.** Gleba cellular, without a columella.

*Rhizoideae.* Peridium attached to the substratum by lateral rhizomorphs.

Spores elliptical, smooth.

Spores hyaline or tinted only.....

Spores deeply coloured.....

Spores globose and verrucose.....

1. **Rhizopogon.**

2. **Melanogaster.**

3. **Sclerogaster.**

*Hymenogastreae.* Peridium attached to the substratum by basal rhizomorphs.

Spores elliptical.....

Spores globose.....

Spores many-angled.....

4. **Hymemogaster.**

5. **Octaviania.**

(*Richoniella*).

**Hysterangioidae.** Gleba cellular, traversed by a simple branched columella.

Spores globose and echinulate.....

6. **Hydnangium.**

Spores elliptical.....

Spores smooth.....

(*Hysterangium*).

Spores verrucose or areolate.....

7. **Gymnoglossum.**

Spored longitudinally ribbed.....

(*Gautieria*).

### 1. RHIZOPOGON Fries.

Symbolae Gasteromycetum 1 (1818) 5 ; emended Tulasne, Giorn. Bot. Ital. 2 (1844) 56.

*Hysteromyces* Vitt. Not. nat. Civ. sulla Lombardia 1 (1844) 340.

Type species : *Rhizopogon luteolus* Fr.

Plants epigaeous or hypogaeous sub- to irregularly-globose or tuberiform, without a definite sterile base. Peridium tough, 1-2 layered, formed of interwoven hyphae which may or may not be gelatinised ; with few or many appressed or free, dark coloured rhizomorphs on the outer surface. Gleba usually some shade of brown, formed of tramal plates anastomosed to form cavities which in section are globose, oval, triangular, elliptical or labyrinthiform in shape. Columella absent. Tramal plates usually of interwoven hyphae which may be gelatinised or not, sometimes becoming scissile. Basidia permanent or soon disappearing, lining the cavities, sub-clavate to cylindrical, 2-8-spored. Sterigmata short. Spores smooth, elliptical with rounded ends, brown in mass, but individually only tinted.

The genus is characterised by the smooth, pale coloured, elliptical spores and the usually lateral or basal, dark coloured rhizomorphs. It is separated from *Melanogaster* on the colour of the spores, which are individually dark in the latter genus.

Of the 38 species described for this genus, Cunningham considers that not more than 12 are good species. Of these seven have been recorded for South Africa, but it is doubtful if more than two or three are distinct species. Work on this genus has been greatly handicapped by the lack of fresh material for examination, unfamiliarity with these plants and great divergence of opinion among workers on the specific characters.

### Key to the Species.

Fresh plants finally yellowish to bay brown.

Gleba strongly gelatinised, drying hard.....

1. **R. luteolus.**

Fresh plants finally reddish brown.

Gleba fleshy, drying firm but not hard.....

2. **R. rubescens.**

Fresh plants dark to black.

Glebal cavities small.....

3. **R. niger.**

Glebal cavities large.....

4. **R. capensis.**

1 *Rhizopogon luteolus* Fries. [Plate I, fig. 1.]

Symbolae Gasteromycetum 1 (1815) 5, emended Tulasne, Giornal Botanica Italiana 2 (1844) 57.

de Toni in Sacc. Syll. Fung. 7 (1888) 161; Zeller and Dodge, Ann. Mo. Bot. Gard. 5 (1918) 10; Verwoerd, S. Afr. Journ. Sci. 22 (1925) 165; Coker and Couch, Gastero. (1928) 33; G. H. Cunningham, Gastero. (1944) 45.

*Rhizopogon induratus* Cooke, Grevillea 8 (1879) 59.

*Melanogaster Wilsonii* Lloyd, Myc. Notes (1923) 1176.

*Rhizopogon Coxii* Mueller, in Herb. Kew.

Plants sub- to irregularly globose or tuberiform, up to 4.5 cm. diam., "Pale ochraceous-tawny, deliquescent after rain, leaving a greenish-yellow mass of unpleasant odour" (sec. A. V. Duthie), drying very hard and ochraceous brown, bay brown or umber with lighter patches. Rhizomorphs usually well developed, dark or reddish brown or paler, laterally appressed, basally loose and strandlike. *Peridium* thick, 136-510  $\mu$ , of loosely interwoven, gelatinised threads, more compact outside than inside, pale golden brown in section. *Gleba* becoming hard; white then pale greyish or yellowish brown, finally between Ochraceous Tawny and Cinnamon Brown or dark amber brown, sometimes with waxy appearance; cavities usually small, 2-5 to mm., subglobose, straight or curved, elliptical, triangular, irregular to labyrinthiform, usually filled with spores. *Tramal plates* thick, 51-102  $\mu$  including the hymenial layer, often becoming scissile along centre, hyaline, of loosely interwoven, gelatinised threads. *Basidia* permanent, hyaline, cylindrical to subclavate, 6-8-spored, forming a compact layer lining the cavities; sterigmata short and threadlike. *Spores* smooth, pale greenish brown in mass in section, 4-8.5  $\times$  3-4  $\mu$ , elliptical with rounded ends, occasionally narrowed at one end or slightly irregular.

*Habitat* : in masses in ground, subhypogeous.

*Distribution* : South Africa; North America; Asia; Australia; Europe; Tasmania; New Zealand.

*Specimens examined* : near Johannesburg, April 1911, I. B. Pole Evans, 1903; Stellenbosch, C.P., A. V. Duthie 77 (Kew ex Herb. C. G. Lloyd) 31335; in clayey ground near hedge, Stellenbosch Flats, Sept. 1919, A. V. Duthie 249, 31430; amongst pine trees, probably near Somerset East, 1882, MacOwan (Rabenh.-Wint. Fung. Eur. 3436; Kew) 20950 as *Melanogaster Owanianum* (Missouri Bot. Gard. Herb. 5646 as *Rhizopogon pachyphloeus* Zeller and Dodge).

*Specimens not seen* : Bloemfontein, Verwoerd.

Dried specimens of this species are characterised by the hard texture of the gleba, the gelatinised hyphae of which the peridium and tramal plates are formed, the spore-filled cavities and the closely compacted basidia forming a permanent layer lining the cavities.

Zeller & Dodge, l.c., considered that *Melanogaster Owanianum* Kalchbr. was the same as their species *Rhizopogon pachyphloeus*, but an examination of two specimens of the South African plant, represented by slices only, failed to disclose any character that could exclude it from *Rhizopogon luteolus* as described by G. H. Cunningham (l.c.) and it has therefore been transferred to the latter species. The two species would appear to be very closely related to each other, since in a previous instance Cunningham (Gastero. 1944: 46, 215) found that an Australian species identified by Dodge as *R. pachyphloeus* was *R. luteolus*. The South African plant differs from *R. pachyphloeus* in a thinner peridium, absence of obvious vesiculose hyphae in the peridium and the colour of the dried gleba, which is dull ochraceous brown, not black with a shiny surface.

2. *Rhizopogon rubescens* Tulasne. [Plate I, fig. 2.]

Giornal Botanica Italiana 2 (1844) 58.

de Toni in Sacc. Syll. Fung. 7 (1888) 161; Zeller & Dodge, Ann. Mo. Bot. Gard. 5 (1918) 18; Verwoerd, S. Afr. Journ. Sci. 22 (1925) 164; G. H. Cunningham, Gastero. (1944) 44.

*Hysterangium rubescens* Tulasne, Ann. Sci. Nat. Ser. II, 19 (1843) 375.

*Melanogaster Berkeleyianus* Broome, Ann. Mag. Nat. Hist. 15 (1845) 41.

*Rhizopogon lapponicus* Karst., Finska Bidr. Nat. Foll. 48 (1889) 19.

Plants gregarious or caespitose, subglobose, depressed to irregularly globose or tuberiform, to 3·2 cm. diam., cream coloured when underground, becoming tinged with red when exposed to the air or touched, drying ochraceous, olivaceous, or dark brown and rugulose; firm for a long time, finally deliquescent. Rhizomorphs cream, then reddish, finally dark as in the case of the plant body, usually few, sometimes almost wanting, appressed or loose, strand-like. *Peridium* uneven, comparatively thin, about 27–238  $\mu$ , golden brown to dark brown in section, of loosely interwoven hyphae approaching pseudoparenchymatous. *Gleba* cream, Honey Yellow to Isabella Colour, bay brown or umber, firm but soft to section; cavities 2–4 to mm., subglobose to sublabyrinthiform, not filled with spores. *Tramal plates* hyaline to tinted yellow or pale brown in section, 34–85  $\mu$  thick, of loosely or compactly interwoven, fine, non-gelatinised hyphae, sometimes scissile. *Basidia* up to 13·6  $\mu$  long, “2–8-spored”, hyaline, subclavate or cylindrical. *Spores* elliptical with rounded ends, smooth, tinted, 6–9  $\times$  3–4  $\mu$ .

*Habitat*: in ground, hypogeous.

*Distribution*: South Africa; North and South America; Asia; Australia; Europe; Tasmania; New Zealand.

*Specimens examined*: under *Pinus pinaster*, Jessievale Plantation, Tvl., *Forester*, 17095, said to be dug up and eaten by buck; du Toit's Park, Stellenbosch, Sept. 1919, *Duthie* 245, 31425; in sandy soil under pines, Pinelands, C.P., June 1929, *E. L. Stephens* 24845; hillside above Marais Park, Stellenbosch, June 1924, *A. V. Duthie* 337 (v. d. Byl 475) 31494; Sterkstroom, C.P., *A. V. Duthie*, 31399.

*Specimens not seen*: Keurboom Park, Newlands, *E. L. Stephens* 336; near Pipe Track, Muizenberg Mt., C.P., Oct. 1938, *P. C. de Kock* (*E. L. Stephens* 464); Capetown University Grounds, Rosebank, June 1935, *E. L. Stephens* 463; Capetown, *MacOwan*, Kew.

This species is distinguished from *R. luteolus* by the usually lesser number of rhizomorphs, the texture of the gleba, which is not gelatinised and firm but soft and easily sectioned, and the fact that the cavities are not filled with spores. No fresh specimens were available for examination and the above description was therefore made chiefly from dried plants. I am indebted to Miss *E. L. Stephens* for information with regard to the colour and texture of the fresh plant.

3. *Rhizopogon niger* (Lloyd) Zeller & Dodge.

Annals of the Missouri Botanical Garden 16 (1929) 122.

*Hysterangium niger* Lloyd, Myc. Writ. 7 (1923) 1173; Verwoerd, S. Afr. Journ. Sci. 22 (1925) 163.

Plants irregularly globose or elongated, drying 3  $\times$  1  $\times$  1·5 cm., externally black, covered with adhering sand. *Peridium* thin, 75–100  $\mu$ , composed of dark brown, thick-walled, nearly parallel hyphae, 2–3  $\mu$  diam. *Gleba* black, soft and sub-gelatinous when fresh, drying Brussels Brown with no greenish tint and probably hard. Cavities small

angular to elongated, not filled with spores. *Tramal plates* about 40–50  $\mu$ , highly gelatinised, traversed through the middle by a layer of deeply staining, closely woven hyphae, the remainder of the gelatin filled with irregularly placed, ellipsoidal to spherical, deeply staining cells which seem to have no visible connection either with the central strand or with each other. *Basidia* narrow filiform, crowding out between the superficial gelatinised cells of the tramal plates, mostly 3-spored. *Spores* brown in mass, slender, ellipsoidal, 7–9  $\times$  2–3  $\mu$ . (Description adapted from Verwoerd, l.c. and Zeller & Dodge, l.c.)

*Habitat* : hypogeous.

*Distribution* : South Africa.

*Specimens not seen* : Knysna, A. V. Duthie (Lloyd Myc. Coll. 22394, Type; Lloyd Mus. 081; Dodge Herb. 353; Zeller Herb. 7246).

According to Zeller & Dodge, this species superficially resembles *R. piceus*; the colour and texture of the gleba is much as in *R. pachyphloeus* but microscopically it is easily distinguishable from either.

#### 4. *Rhizopogon capensis* Lloyd ex Verwoerd.

Verwoerd, South African Journal of Science 22 (1925) 165; Lloyd, Mycological Writings 7 (1924) 1321, nomen nudum.

Plants subglobose or irregularly globose, 2–6 cm. diam., dark coloured, soon deliquescent. Rhizomorphs abundant, especially towards the base, black. *Peridium* thick, 272–408  $\mu$  diam., persistent, subcoriaceous, yellowish brown, composed of interwoven hyphae, often vesiculose and with scattered, oblong olivaceous bodies scattered here and there. *Gleba* fleshy, composed of large cavities, raw umber brown. *Tramal plates* 68–102  $\mu$  thick, of interwoven hyphae. *Spores* elliptical, subhyaline, 6–8.5  $\times$  3–3.4  $\mu$ , smooth.

*Habitat* : subhypogeous, under pine trees; said to be relished by slugs and millipedes.

*Distribution* : Western Cape Province, South Africa.

*Specimens examined* : Pinelands, E. L. Stephens 335 (formalin preserved specimens only).

*Specimens not seen* : in clayey soil under pine trees, Stellenbosch, C.P., Verwoerd, type; Stellenbosch, Sept. 1924, A. V. Duthie (E. L. Stephens 416).

According to Miss E. L. Stephens, *R. capensis* can easily be distinguished from *R. rubescens* in the fresh condition. The fruit body and rhizomorphs of the former are both dark coloured, while those of the latter are cream coloured when underground, becoming tinged with red when exposed or touched. Further, *R. capensis* is usually much larger and deliquesces at an earlier stage, with the result that at maturity it is quite soft, while *R. rubescens* is still quite firm.

#### Uncertain Species.

##### *Rhizopogon radicans* Lloyd.

Mycological Writings 7 (1923) 1174.

Verwoerd, S. Afr. Journ. Sci. 22 (1925) 165.

Verwoerd, l.c., states concerning this species: "Lloyd who named this fungus, doubts very much whether it really is a distinct species. He considers it to be near to *R. provincialis*, from which it differs in having a short, thick, rooting base, which, when broken, is seen to be composed of brown hyphae without chambers or spores".

*Specimen not seen* : Knysna, C.P., A. V. Duthie (Lloyd Myc. Coll. 50861, Type).

## 2. MELANOGASTER Corda.

in Sturm's Deutschlands Kryptogamen-flora 3 (1831) 1.

*Uperhiza* Bosc., Mag. Ges. Nat. Freunde 5 (1811) 88.

*Bullardia* Jungh., Linnaea 5 (1830) 408.

*Argylium* Wallr., Fl. Crypt. Germ. 2 (1833) 874.

Type species: *Melanogaster variegatus* (Vitt.) Tul.

"Plants hypogean, subglobose or irregularly tuberiform; with branched rhizomorphs arising from the exterior of the peridium, more numerous basally. Peridium of a single tough layer of woven gelatinised hyphae, continuous with the tramal plates. Gleba of tramal plates anastomosed to form numerous polygonal or subglobose cavities, which are usually larger towards the centre and filled with spores at maturity; columella absent; hymenium of clavate, 2-8-spored basidia (commonly 2-4) irregularly distributed through a broad hyphal zone lining the cavities. Spores borne on short sterigmata, elliptical or lemon-shaped, deeply coloured, smooth, shortly pedicellate" (after Cunningham, Gastero. 1944: 46).

This genus is distinguished from *Rhizopogon*, which it closely resembles superficially, by the dark spores. It is further characterised by the fact that the basidia are not compacted into a palisade hymenium, but are irregularly borne on interwoven hyphae which line the cavities.

According to the International Rules of Botanical Nomenclature, both the generic names *Uperhiza* and *Bullardia* antedate *Melanogaster*, but on Maire's proposal (Rec. Synop. v. Congres internat. Bot. 1930: 120) it was agreed that the latter name should be treated as a *nomen conservandum* on the grounds that it had been in use for more than a century, whereas the other two had been ignored.

About ten species have been described for this genus, but Cunningham, l.c., considers that of these only four or five are probably good species, the others being synonyms of these or of species of *Rhizopogon* or *Hymenogaster*. So far only one collection of one species has been recorded for South Africa.

***Melanogaster ambiguus* (Vittadini) Tulasne.** [Plate I, fig. 4.]

*Fungi Hypogaei* (1851) 94.

Coker & Couch, Gastero. (1928) 41; G. H. Cunningham, Gastero. (1944) 47.

*Octaviania ambigua* Vitt., Mon. Tuberacearum (1831) 18.

Plants hypogeous, depressed-globose to irregularly tuberiform, 1.2-3.2 cm. wide, 0.8-1.9 cm. high, brown (Snuff Brown) drying very hard; rhizomorphs concolorous or darker, adpressed. Peridium single, less than 1 mm. thick, smooth to rugulose, drying very much dented. Gleba consisting of tramal plates anastomosed to form globose, subglobose to irregular cavities filled with spores at maturity. Tramal plates thin, ochraceous, at times almost obscured by the dark masses of spores, consisting of gelatinised, fine, interwoven threads. Spores purplish black in mass, dark brown individually, typically lemon shaped or fusiform, occasionally subglobose, smooth or obscurely verruculose, at times very shortly pedicellate, pedicel hyaline, broken off, 11.9-20  $\times$  7-10  $\mu$  diam. Smell very strong, resembling garlic.

*Habitat*: under cultivated garden plants.

*Distribution*: South Africa; North America; Europe; India; New Zealand.

*Specimens examined*: under *Hydrangeas* in shade of oak trees, Howick, Natal, Nov. 1930 G. A. Gill, 25506.

3. **SCLEROGASTER** Hesse.

*Hypogaeen Deutschlands* 1 (1891) 84.

Sacc. Syll. Fung. 11 (1895) 170; Bataille, Bull. Soc. Myc. France 39 (1823) 180; Coker & Couch, Gastero. East U.S. & Canada (1928) 25; Ed. Fischer, Nat. Pflanzenfam. 7a (1933) 18.

Type species: *Sclerogaster lanatus* Hesse.

"Fructifications small, white, embedded in a thick, flocculent mycelium, attached by rooting fibrils; peridium usually soft; gleba usually pale yellowish, gelified, drying very hard, cavities small, usually filled with spores similar to *Leucogaster* in shape; basidia small cylindric to clavate, sterigmata short; spores small, thick-walled, spherical, appearing smooth under lower magnifications, but mostly minutely echinate to verrucose under higher powers" (after Zeller & Dodge, Ann. Mo. Bot. Gard. 23, 1936: 567).

According to Zeller & Dodge, l.c., "this genus seems to form a transition between *Leucogaster* and *Hydnangium* or *Arcangelia*. The spores are much smaller than the average in the above genera and have a relatively thicker wall. In some species there are faint suggestions of a columella but no lactiferous ducts have been seen. In general appearance the fructifications resemble *Leucogaster* but have very minute cavities. They have usually been included in *Hydnangium* (*Octaviania* Auct. non Vitt.) on account of the echinate spores".

Zeller & Dodge list ten species for this genus, three occurring in North America and the remainder in Europe. Up to the present only one species has been recorded for Southern Africa, viz. *S. salisburyensis* Verwoerd, collected in Southern Rhodesia.

**Sclerogaster salisburyensis** Verwoerd.

South African Journal of Science 23 (1926) 293.

Plants up to 6 cm. diam., globose or irregularly globose. Peridium thick, 1-3 mm., persistent, convoluted, dirty white. Gleba fleshy, drying hard, dirty cream coloured, consisting of numerous, small, irregular but definite cellular cavities; no sterile base. Spores globose, 10.8-14.4  $\mu$  diam., reticulated, hyaline, episporic 1.8  $\mu$  thick (translation from Verwoerd, l.c.).

*Habitat*: in ground in bushveld.

*Distribution*: Southern Rhodesia.

*Specimen not seen*: Salisbury, S. Rhodesia, Jan. 1924, F. Eyles 4104 (v. d. Byl 2224).

4. **HYMENOGASTER** Vittadini.

Monographia Tuberacearum (1831) 20.

de Toni in Sacc. Syll. Fung. 7 (1888) 168; Ed. Fischer in Engler & Prantl. Nat. Pflanz. I, 1\*\* (1899) 308; 7a (1933) 14; Dodge & Zeller, Ann. Mo. Bot. Gard. 21 (1934) 628; G. H. Cunningham, Gastero. (1944) 47.

*Hymenangium* Corda, Icon. Fung. 5 (1842) 28.

*Protoglossum* Massee, Grevillea 19 (1891) 97.

*Hysterochaster* Zeller & Dodge ex Dodge, Comp. Morph. Fungi (1928) 488.

Type Species: *Hymenogaster citrinus* Vitt. (sec. Cunningham).

*Hymenogaster Bulliardii* Zeller & Dodge (sec. Zeller & Dodge, l.c.).

Plants partly or entirely hypogeous, subglobose, irregularly globose, pyriform, attached to the substratum by basal rhizomorphs, fibrils rarely present. Peridium usually simple, 1-2 layered, prosenchymatous, pseudo-parenchymatous or of interwoven hyphae, usually

confluent with the tramal plates, indehiscent. Gleba usually some shade of brown, composed of tramal plates amastomosed to form sub-globose to irregular cavities lined with spore-bearing hymenium and arranged irregularly or more or less radiating from a small hemispherical or conical sterile base; columella absent. Tramal plates hyaline to coloured, usually gelatinised and loosely or closely pseudoparenchymatous, often scissile at the axis. Basidia cylindrical, 2-4-spored, long or short sterigmate. Spores coloured, usually some shade of brown, smooth or verrucose, rugose, alveolate or reticulate, with or without a more or less wrinkled utricle, ovate, ellipsoid, broadly fusiform, citriform, with or without an apiculus or pedicel.

The genus *Hymenogaster* is world wide in distribution, though more prevalent in the Northern than in the Southern Hemisphere. It differs from *Octaviania* and *Richoniella*, its nearest relatives, in having elliptical spores, from *Rhizopogon* and *Melanogaster* in its attachment to the substratum by basal instead of by lateral rhizomorphs and from *Hydnangium*, *Hysterangium*, *Gymnoglossum* and *Gautieria* in the absence of a columella.

Numerous species have been described for this genus, but probably not more than three or, at most, four of these have so far been found in South Africa, but a systematic search for these fungi would probably bring to light a number more.

The members of this genus have received little attention from South African mycologists up to the present. With the exception of a single specimen found on the damp walls of a dark cave in Natal, these fungi are only known from the western Cape Province and such few collections as have been available for examination consist of one or, at most, two dried specimens only. In addition to the paucity of material, the difficulty of placing these collections in species has been very great owing to the lack of any named specimens for comparison. Reliance for identification has therefore been placed entirely on published descriptions, which is very unsatisfactory owing to the variable nature of these fungi. The names used must therefore be considered to be of a tentative nature until fresh material and authentically named specimens are available for study.

The separation of the species has been based on spore characters rather than on the thickness of the peridium, as was done by Dodge & Zeller, l.c., owing to the very variable nature of this character at different ages of the fungus and in the dried and fresh condition.

For the guidance of future workers in South Africa, the Australian and New Zealand species have been included in the key, since these are more likely to occur in this country than European or North American species.

#### Key to the Species.

Spores smooth or nearly so, without utricle.

Spores small, 7-10  $\mu$  long.

Peridial wall of woven hyphae..... 1. *H. levisporus*.  
(*H. fuligineus*).

Spores 13-16  $\mu$  long.

Peridium reddish brown..... (*H. tasmanicus*).  
Peridium golden yellow..... (*H. aureus*).

Spores 18-22  $\mu$  long..... (*H. fusisporus*).

Spores covered with a rugulose-areolate or verrucose utricle.

Peridium 2-layered..... (*H. viscidus*).

Peridium 1-layered.

Spores 12-16  $\mu$  long.  
Spores elliptical; basidia 4-spored..... (*H. nanus*).

Spores fusiform; basidia 2-spored..... 2. *H. albellus*.

Spores 16-22  $\mu$  long..... 3. *H. Zeylanicus*.

Spores with a strongly reticulated utricle.

Endospore thick..... (*H. macrosporus*).  
Endospore thin..... (*H. reticulatus*).

1. *Hymenogaster levisporus* Massee & Rodway.

Rodway, Proceedings of the Royal Society of Tasmania for the Year 1911 (1912) 30.

*Hymenogaster Maideni* Rodway, Proc. Roy. Soc. Tasm. for 1920 (1921) 157.

*Octaviania levispora* Rodway, Proc. Roy. Soc. Tasm. for 1923 (1924) 157.

Plants irregularly globose, up to 3 cm. diam., whitish, drying buff-coloured and rugulose. *Peridium* thin, varying in thickness 68–204  $\mu$ , outline irregular, of closely woven hyphae, compact except on outside where more loosely interwoven, dark brown on the outside and golden brown next to the gleba. *Gleba* becoming brown, consisting of anastomosed tramal plates forming minute, irregular to labyrinthiform cavities filled with spores. *Tramal plates* 17–51  $\mu$  without the hymenium, hyaline, compact, of densely woven hyphae. *Sterile base* not seen. *Basidia* 4-spored. *Spores* when mature pale brown, elliptical or obovoid-elliptic, occasionally subglobose, 6.8–10.2  $\times$  4.4–5  $\mu$ , smooth.

*Habitat*: in soil.

*Distribution*: South Africa; Australia; Tasmania.

*Specimens examined*: sub-hypogeous, Kirstenbosch, C.P., June 1934, E. L. Stephens 368, 27674, probably immature.

This species is distinguished by its whitish peridium (in fresh condition) and small, smooth spores.

2. *Hymenogaster albellus* Massee & Rodway. [Plate I, fig. 3.]

Massee, Kew Bulletin of Miscellaneous Information (1898) 126.

Sacc. & Sydow in Sacc. Syll. Fung. 16 (1902) 253; Rodway. Papers and Proc. Roy. Soc. Tasmania (1911) 28, (1923) 152; Dodge & Zeller Ann. Mo. Bot Gard. 21 (1934) 669; G. H. Cunningham, Gastero. (1944) 52.

*Hymenogaster luteus* Harkness, Proc. Calif. Acad. Sci. Bot. III, 1 (1899) 247—not Vittadini.

Plants irregularly subglobose, up to 5 cm. diam., drying areolately fissured or not at the apex, white, becoming pale buff, pale greyish ochraceous or umber and wrinkled or rugulose. *Peridium* thin, 34–204  $\mu$ , 1–2 layered; the outer apparently disappearing with age, hyaline, irregular in outline, varying in thickness from 13–85  $\mu$  and formed of loosely interwoven hyphae; the inner layer pale golden brown and of more or less the same texture as the hyaline layer and merging into it, or with a definite, darker, more compact zone of tissue adjacent to the hyaline, giving the peridium the appearance of being 3-layered. *Gleba* brown (between Sayal and Cinnamon Brown) attached to the peridium, consisting of tramal plates anastomosed to form numerous, small, 1–4 to mm., subglobose to irregular or sub-labyrinthiform cavities with parallel hymenium, filled with spores. *Tramal plates* 10.2–44  $\mu$  thick (up to 135  $\mu$  in formalin specimens) from tinted to golden brown, gelatinised, loosely interwoven to more or less compact except at the axils where pseudoparenchymatous and often scissile. *Basidia* 2-spored, short to long sterigmate. *Spores* when mature umber brown, lemon-shaped with obtusely papillate, often hyaline apex or ovoid-acuminate, sometimes broadly sub-fusiform, less often broadly oval, evenly covered, except for the apical papilla, with a utricle which is delicate and hyaline in the immature spore, becoming brown tinted and clearly defined with age, 13.6–20.4  $\times$  6.8–12  $\mu$ , sometimes apiculate or shortly pedicellate in young spores.

*Habitat*: entirely or sub-hypogeous.

*Distribution*: South Africa; Australia; North and South America; New Zealand.

*Specimens examined*: half buried in soil, Stellenbosch, C.P., Aug.–Sept. 1937, A. V. Duthie 209, 28866, det. Dodge & Zeller, l.c.; A. V. Duthie 324, 28867, det. Lloyd as *H. lilacinus* Tul.; Cape Town, July 1911, L. Peringuey, 1735; Groote Schuur, C.P., Aug. 1933, J. Acocks (E. L. Stephens 259) 35544.

This species is characterised by the thin, whitish peridium, the brown gleba and the brown, lemon-shaped to ovoid-acuminate spores provided with a delicate to clearly defined, even, hyaline to coloured, roughened or areolate utricle.

Lloyd's identification of *Duthie 324* as *H. lilacinus* was based entirely on Tulasne's figures of the gleba and spores of this species; Dodge and Zeller identified *Duthie 209* as *H. albellus*, and since the two collections appear to be of the same plant, with slight age differences, it has been decided to refer both to *H. albellus*. Subsequent workers may decide that collection No. 1735 is some species other than *H. albellus* as here defined, since the spores are larger, the utricle tinted and more clearly defined and the peridium thinner and without an outer hyaline layer.

### 3. *Hymenogaster Zeylanicus* Petch.

Annals of the Royal Botanic Gardens, Peradeniya 6 (1917) 207.

Trotter, Sacc. Syll. Fung. 23 (1925) 599; Dodge & Zeller, Ann. Mo. Bot. Gard. 21 (1934) 676; G. H. Cunningham, Gastero. (1944) 52.

Plants pyriform, 1 cm. diam., greyish white, drying brownish and deeply rugulose to almost pitted. *Peridium* 170–306  $\mu$  thick including the hymenium, hyaline, delicate, easily separating from the gleba, formed of loosely interwoven, coarse, thin-walled, hyaline hyphae, the outer part with numerous, globose to irregular vesicular hyphal cells. *Sterile base* present, small, white, pulvinate. *Gleba* pale olivaceous brown, consisting of tramal plates anastomosed to form subglobose to irregular cavities more or less radiating from the sterile base; cavities small, 4 to 1 mm., adjacent to the sterile base, increasing in size to 1 mm. diam. towards the apex. *Tramal plates* hyaline, 6.8–102  $\mu$  thick including the hymenium, formed of loosely interwoven, coarse hyphae similar to the tissue in the inner part of the peridium. *Basidia* 2-spored, clavate, hyaline. *Spores* when mature brown, 15–24  $\times$  8.5–13.6  $\mu$  diam., broadly ovoid-fusiform or lemon-shaped, apex bluntly acuminate, base apiculate or shortly pedicelled, finely verrucose, covered, except at the apex, with a hyaline, faintly areolate utricle which is often laterally expanded at the base producing a truncate effect.

*Habitat* : hypogeous.

*Distribution* : Australia; Ceylon; New Zealand; ? South Africa.

*Specimen examined* : on damp sandstone walls of a dark cave, Noodsberg, Natal, May 1937, R. P. Lawrence, 28873; one specimen only, preserved in formalin.

This species is characterised by the large areolated spores and the hyaline, loosely interwoven peridium.

According to the original description of Petch, l.c., the basidia are monosporous, the spores 12–16  $\times$  8–9  $\mu$  and the tramal plates 10  $\mu$  thick; but according to Cunningham, who examined part of the type collection now in the Lloyd herbarium (No. 37975) these characters are incorrect.

It is not certain that the South African plant here described is *H. zeylanicus* since Cunningham makes no mention of any sterile base and Dodge & Zeller state that it is absent. However, until further material is available for study, it seems preferable to refer it tentatively to this species, to which it seems very closely related, than to erect a new species from a single specimen.

### Doubtful Species.

#### *Hymenogaster arenarius* Tulasne.

Giornale Botanico Italiano 12 (1844) 55.

Tulasne, Fung. Hypog. (1851) 73; de Toni, Sacc. Syll. Fung. 7 (1888), 168; Soehner, Hedwigia 64 (1923) 192; Dodge & Zeller, Ann. Mo. Bot. Gard. 21 (1934) 674.

*Hymenogaster pusillus* Berk. & Broome, Ann. & Mag. Nat. Hist. I, 18 (1846) 75.  
*H. Suzukianus* Henn., Engl. Bot. Jahrb. 32 (1902) 41.

" Fructifications spherical to obovate, about 1 cm. diam., white, unchanging, smoke grey in alcohol, drying Brussels brown; sterile base slight; peridium 200-320  $\mu$  thick when fresh, composed of large, thin-walled, hyaline hyphae 7-8  $\mu$  diam., drying to about 35-40  $\mu$  thick (in the type); gleba white, becoming smoke grey, cavities more or less spherical, radiating from the base; septa 70-100  $\mu$  thick, with trama proper about 22-35  $\mu$  thick, of large, thin-walled, compact prosenchyma, the cells of which are 3-5  $\mu$  in diameter, with a pseudoparenchymatous subhymenium; basidia 30-35  $\times$  5-7  $\mu$ , cylindrical, sterig-mata long; spores ovoid- to ellipsoid-citriform, coarsely verrucose (6-8 warts to a spore length), apiculate, pedicellate, 11-18  $\times$  8.5-11  $\mu$ , rufous brown ". (ex Dodge & Zeller, l.c.).

*Habitat* : " in sandy or gravelly soil in woods ".

*Distribution* : " cosmopolitan in the northern hemisphere " ; ? South Africa.

*South African specimens* : record only by Lloyd (Myc. Writ. 6, Myc. Notes 61, 1919 : 889) of specimen collected by Miss A. V. Duthie, locality not mentioned. Lloyd is uncertain of his determination and in view of the known distribution of the fungus, it seems very probable that it is not *H. arenarius*. Lloyd's very meagre description suggests that the fungus might possibly be *H. albellus*, which was collected by Dr. Duthie on at least two occasions.

##### 5. OCTAVIANIA Vittadini.

*Monographia Tuberacearum* (1831) 15 ; emended *Tulasne, Fungi Hypogaei* (1851) 77  
 Ed. Fischer, *Nat. Pflanzenfam.* 7a (1933) 17 ; *Verwoerd, S. Afr. Journ. Sci.* 22 (1925) 163 ; G. H. Cunningham, *Gastero.* (1944) 54.

*Gymnomyces* Mass. & Rodw. ex Mass. *Kew Bull.* (1898) 125.

*Octavianina* Kunze, *Rev. Gen. Pl.* 2 (1898) 501.

*Martellia* Matt., *Malpighia* 14 (1900) 42.

*Stephanospora* Pat., *Bull. Soc. Myc. Fr.* 30 (1914) 349.

Type species : *Octaviania asterosperma* Vitt.

Plants subglobose to pyriform, attached by a basal root. Peridium 1-2-layered, sometimes partly disappearing, composed of compact or loosely formed pseudoparenchymatous tissue or of interwoven hyphae. Gleba consisting of trama plates anastomosed to form globose, elliptic or sub-labyrinthiform cavities filled or not with spores. Sterile base present or absent. Columella wanting. Basidia permanent or not, cylindrical or clavate, 2-4-spored, sterigmate. Spores hyaline to dark coloured, globose, echinulate, verrucose or reticulated.

G. H. Cunningham, l.c., supplies the following notes on this genus :— " The genus was erected by Vittadini to contain several species which all, save *O. asterosperma*, have since proved to belong to *Melanogaster*. In 1839 Wallroth erected *Hydnangium*, but as he did not clearly define the genus, most workers have regarded it as a synonym of *Octaviania*. Dodge (Ann. Missouri Bot. Gard. 1928 : 486) adopted a converse attitude and held *Octaviania* to be invalid since . . . the immature condition of a number of species was misinterpreted, and at one time the name of *Octaviania* was applied to them, incorrectly since it was originally used as a synonym of *Melanogaster* ". His treatment is at variance with the facts and the International Rules of Botanical Nomenclature. Fischer (Nat. Pflanz. 7a, 1933 : 17) clarified the position by showing that *Hydnangium* was based on a valid species differing from those placed under *Octaviania* in possessing a dendroid columella ".

With regard to the synonyms listed above, Fischer treats *Gymnomyces* and *Martellia* as distinct genera but Cunningham considers that they are synonyms of *Octaviania* for the following reasons :—“ *Gymnomyces* was erected to contain plants without a definite peridium ; but as this structure is present in the type specimens and in all collections of the species I have examined, the genus is invalid. *Martellia* possesses no feature of generic importance which would separate it from *Octaviania*, the absence of a sterile base and the arrangement of the glebal chambers being features present in many typical species of the latter genus ”.

About twenty-four species have been described for the genus under discussion but not more than two are known to occur in South Africa.

### Key to the Species.

Peridium of pseudoparenchymatous tissue. Basidia disappearing ..... 1. *O. africana*.  
Peridium of loosely interwoven, often vesicular hyphae. Basidia permanent .... 2. *O. flava*.

#### 1. *Octaviania africana* Lloyd.

*Mycological Writings* 7, *Myc. Notes* 67 (1922) 1142.

Verwoerd, *S. Afr. Journ. Sci.* 22 (1925) 164.

*Sclerogaster africanus* Lloyd, *Myc. Writ.* 5, Letter 64 (1916) 4, nom. nud.

*Arcangeliella africana* (Lloyd) Zeller & Dodge, *Ann. Mo. Bot. Gard.* 23 (1936) 614.

Plants subglobose, up to 2 cm. diam., dark brown, smooth, drying rugulose, attached by a short basal root. *Peridium* 1-layered, 68–136  $\mu$  thick, pseudoparenchymatous, fairly compact and more or less uniform, the outer cells slightly more compact than the inner. *Gleba* consisting of tramal plates anastomosed to form small, subglobose, oval or irregular cavities, reddish brown, the tramal plates paler than the spore masses which fill the cavities. No sterile base or columella seen. *Tramal plates* pale brown, 17–51  $\mu$  thick, usually compactly pseudoparenchymatous except at the axils where the cells are thin-walled, large and often scissile. *Basidia* not seen. *Spores* ochraceous to umber brown, globose, thick-walled, 15.3–20.4  $\mu$  diam., grossly echinulate, echinulae pyramidal or finger-like.

*Habitat* : in humus, sub-hypogeous.

*Distribution* : South Africa.

*Specimens examined* : Forest Hall, Knysna, *A. V. Duthie* 97 (v. d. Byl 2097 ; Lloyd Myc. Coll. 7198) 31350.

This species is characterised by the single, uniform, pseudoparenchymatous peridium and the large, brown, grossly echinulate spores.

There seems to be some difference of opinion about this species. Lloyd, l.c., described the spores as globose and minutely tubercular reticulate, Verwoerd, l.c., as ovate and reticulate, Zeller and Dodge, l.c. as “ ellipsoidal, alveolate, slightly foveolate under alveolate ” ; in the portion of the type material examined by me they are definitely globose and grossly echinulate. Zeller & Dodge further differ in the matter of the peridium which they described as ‘ duplex, formed of loosely woven, septate hyphae ’ with a combined thickness of 525–560  $\mu$  which is about four times the thickness of the peridium in the specimens seen by me. They also recorded the presence of lactiferous ducts and on this account transferred the specimens to their genus *Arcangeliella*. Finally they quote *Duthie* 325 as the collection on which Lloyd based his species, whereas this should be *Duthie* 97, *Duthie* 325 being that named by Lloyd *Octaviania carneae* which also differs from their description in a thinner peridium, absence of lactiferous ducts and in having coarsely echinulate instead of ellipsoidal, alveolate spores. These differences suggest that the collection seen by Zeller and Dodge may have included more than one species or that a

confusion of specimens may have arisen. In any case it seems very improbable that the specimens seen by them are the same as that part of the type collection which Dr. Duthie presented to the National Herbarium at Pretoria.

The genus *Arcangeliella* was erected by Zeller & Dodge for plants of the *Octaviania* and *Hydnangium* type which showed the presence of lactiferous ducts. Cunningham (Gastero, 1944 : 63), however, asserts that the latter may or may not be present in individual plants of the same collection and that therefore this character is not of generic value. For this reason, strengthened by the fact that no lactiferous ducts were found in the material examined, the specimens from which the above description was made have been referred back to *Octaviania africana* Lloyd.

**2. Octaviania flava** (Rodway) G. H. Cunningham.

Transactions of the Royal Society of New Zealand 67 (1938) 408.

G. H. Cunningham, Gastero. (1944) 57.

*Gymnomyces flavus* Rodway, Proc. Roy. Soc. Tasmania for 1917 (1918) 110.

Plants subglobose or irregularly tuberiform with several lobes, up to 10 mm. high, 18 mm. wide, white when preserved in formalin, attached by a basal rhizomorph. *Peridium* thin, probably about 120  $\mu$ , delicate, smooth, composed of loosely interwoven, coarse, hyaline, often vesicular hyphae. *Gleba* whitish, consisting of tramal plates anastomosed to form subglobose-elongated to labyrinthiform, relatively large cavities, up to 2 mm. long diam., not filled with spores and more or less radiating from a small sterile base. No columella present. *Tramal plates* hyaline, thick, 68–306  $\mu$ , composed of loosely interwoven, coarse, hyaline, often vesiculose hyphae. *Basidia* 2-spored, cylindrical or clavate, forming a parallel hymenium layer, sterigmate, sterigmata short, about 7  $\mu$ , stout. *Spores* globose, hyaline, echinulate, 10–16  $\mu$  diam. (Description from material preserved in formalin.)

*Habitat* : hypogeous.

*Distribution* : South Africa; Australia; Tasmania.

*Specimens examined* : on damp sandstone wall of dark cave, Noodsberg, Natal, May 1937, R. P. Lawrence, 28872.

This species is distinguished by the loosely interwoven hyphal peridium and tramal plates and the echinulate spores. The South African specimens appear to agree very well with Cunningham's description, i.c., of the species as far as the known characters are concerned. Information with regard to the colour of the fresh and the dry plant is not available.

**6. HYDNANGIUM** Wallroth.

in Dietrich's Flora Regni Borussici 7 (1839) 465; emended Ed. Fischer, Nat. Pflanzen fam. 7a (1933) 30.

G. H. Cunningham, Gastero. (1944) 63.

*Arcangeliella* Cav., Nuovo Giorn. Bot. Ital. 7 (1900) 117.

*Maccagnia* Matt., Mem. R. Accad. Naz. Lincei, Ser. 5, 13 (1922) 17.

Type Species; *Hydnangium carneum* Wallr.

" Plants subglobose or pyriform, attached by a radicate rhizomorph. Peridium simple often reduced, of woven gelatinised hyphae. Gleba of permanent tramal plates anastomosed to enclose labyrinthiform cavities, lined with a permanent palisade hymenium; columella dendroid, arising from a well-defined sterile base. Spores globose, echinulate, pallid coloured; basidia clavate, 1–4-spored, commonly 2-spored, sterigmate" (after Cunningham i.c.).

Cunningham supplies the following notes on the genus:—"As emended by Fischer, *Hydnangium* may be regarded as an *Octaviania* with the gleba traversed by a dendroid columella and a coralloid—not lacunar—type of development.

"*Arangeliella* is regarded as a synonym, since it differs merely in the occasional presence of lactiferous ducts. These bodies may be present or absent in individual plants of the same collection, consequently they cannot be regarded as of generic value. Frequently when they are present, they cannot be detected in dried plants unless sections are specifically treated, which renders their use hazardous in diagnosis. Zeller & Dodge appeared to regard the lactiferous character of greater generic significance than the presence or absence of a columella, or shape and sculpturing of the spores. In the result, in their various papers they have placed under the genus species which belong to several genera."

"Twenty species of *Hydnangium* have been described, the majority doubtless being members of *Octaviania*."

So far as is known, only two species of this genus have been recorded for South Africa and of these one seems rather doubtful.

***Hydnangium carneum* Wallroth.**

in Dietrich's Flora Regni Borussici 7 (1839) 465.

G. H. Cunningham, Gastero. (1944) 63.

*Octaviania carneae* (Wallr.) Corda, Icon. Fung. 6 (1854) 361; Verwoerd, S. Afr. Journ. Sci. 22 (1925) 164.

*O. Archeri* Berk., Fl. Tasman. 2 (1860) 263.

*Hydnangium Soderstromii* Lagerh. ex Lagerh. & Pat., Bull. Soc. Myc. Fr. 9 (1893) 142.

*Hydnangium Archeri* (Berk.) Zeller & Dodge, Ann. Mo. Bot. Gard. 22 (1935) 371.

*Octaviania columellifera* Kobayasi, Bot. Mag. 51 (1937) 297.

Plants globose, to 15 mm. wide, 10 mm. high, drying ochraceous and rugulose. Peridium 34–102  $\mu$  thick, 2-layered, outer layer irregular, composed of compactly interwoven hyphae, inner layer reddish brown, of same texture as outer layer. Gleba ochraceous brown, consisting of tramal plates anastomosed to form subglobose, elliptic or sub-labyrinthiform cavities lined with permanent hymenial layer; cavities filled with spores or not. "With distinct sterile base" sec. Verwoerd. Columella not seen. Tramal plates 34–102  $\mu$  thick, reddish brown with paler centre, pseudoparenchymatous, usually compact except at axis where cells large and sometimes scissile. Basidia cylindrical to subclavate, permanent, 1–4-spored, with long sterigmata. Spores globose, pale ochraceous, thick-walled, strongly echinulate, echinulae pyramidal or finger-like, 10·2–17  $\mu$  diam.

*Habitat* : in ground.

*Distribution* : South Africa; Australia; Europe; New Zealand; Tasmania.

*Specimens examined* : Stellenbosch Flats, Stellenbosch, C.P., Sept. 1921, A. V. Duthie 325 (v. d. Byl 2096) 28871, det. Lloyd as *Octaviania carneae*.

According to Cunningham, this species is characterised by the large, sinuous cells of the gleba, the fragile, often evanescent peridium, which may be well developed, rudimentary or absent, and the large, coarsely echinulate spores. The dendroid columella, on the presence of which the species was removed from *Octaviania* to *Hydnangium*, was not seen by me nor apparently by Verwoerd, but, in view of the fact that Dr. Duthie sent part of her collection to Lloyd for determination and the material retained consists of only a few broken slices, it is quite possible that the latter were cut from the sides of the specimen and so do not show the columella. The sterile base was likewise not seen in the material available, but Verwoerd, i.e., records the presence of such in his description.

## Uncertain Species.

**Hydnangium nigricans** Kalchbrenner.

Grevillea 10 (1882) 107.

Saccardo, Syll. Fung. 11 (1895) 172; Dodge &amp; Zeller, Ann. Mo. Bot. Gard. 23 (1936) 592.

"Fructification  $1.5 \times 2$  cm., depressed globose, drying black, smooth, no trace of sterile base or columella in sliced fructifications; peridium  $260-270 \mu$  thick, composed of large, thin-walled prosenchyma; gleba ochraceous-tawny, cavities small, septa thin,  $14-15 \mu$  between hymenia (in dried material) appearing as slender, irregular, gelified hyphae but perhaps similar to the peridium, badly collapsed; basidia about  $30 \times 11$ , collapsing in the upper half on the separation of the spore; spores  $12-19 \mu$  in diameter, dark brown, with closely set, conical spines on a thick episporo" (description ex Dodge & Zeller, l.c.)

*Habitat* : under trees.*Distribution* : South Africa.

*Specimen not seen* : in grass under Acacia trees at foot of Boschberg Mts., near Somerset East, C.P., MacOwan 1211 (type in Kew Herb. and in Bot. Mus. Berlin).

The above specimen is probably not a *Hydnangium* in the sense of Cunningham, whose arrangement is followed here, since no columella was found in the specimen examined by Zeller & Dodge, unless, as happens in other cases of MacOwan's collections, the specimens consisted of slices cut from the sides of the fruit body, in which case neither sterile base nor columella, even if present, would be evident. No specimen of *H. nigricans* is lodged in any herbarium in South Africa.

It should be noted that Kalchbrenner quotes *MacOwan 1211* for both *MacOwanites agaricinus* and the plant in question.

7. **GYMNOGLOSSUM** Massee.

Grevillea 19 (1891) 97.

Cunningham, Gastero. (1944) 71.

*Dendrogaster* Buch., Hedwigia 40 (1901) 316.Type Species : *Gymnoglossum stipitatum* Mass.

Plants subglobose or pyriform, attached to the substratum by a well developed basal rhizomorph. Peridium of one or two layers, pseudoparenchymatous. Gleba of pseudoparenchymatous trama plates, anastomosed to enclose numerous cavities which are lined with a definite hymenial layer; traversed by a branched columella, which may be reduced to a sterile base with a few radiating trabeculae. Spores elliptical, coloured, with a rugulose exospore; basidia persistent, bearing 2-4 spores on short sterigmata" (after Cunningham).

The distinguishing characters of this genus are the branched columella and coloured elliptical spores. It differs from *Hymenogaster* in having a branched columella, but the latter is at times very poorly developed and it is therefore sometimes not easy to distinguish between the two genera.

Zeller & Dodge (Ann. Mo. Bot. Gard. 21, 1934 : 684) used the name *Dendrogaster* in their work on the genus, but Cunningham, l.c., subsequently pointed out that Massee described *Gymnoglossum* from an incomplete specimen in which the peridium had fallen off, and, as the presence or absence of a peridium is the main difference between the two genera, *Gymnoglossum* has priority.

The genus in South Africa is at present known from only one small collection doubtfully named by Lloyd as *Hymenogaster radiatus* and later referred by Zeller & Dodge, l.c. p. 688, to *Dendrogaster*. This is now referred to *Gymnoglossum* in accordance with Cunningham's views.

**Gymnoglossum radiatum** (Lloyd) Bottomley n. comb.

*Hymenogaster radiatus* Lloyd, Myc. Writ. 7, Myc. Notes 73 (1925) 1304; Verwoerd, S. Afr. Journ. Sci. 22 (1925) 160.

*Dendrogaster radiatus* (Lloyd) Zeller & Dodge, Ann. Mo. Bot. Gard. 2 (1934) 688.

Plants hypogeous, 1-2.5 cm. diam., subglobose, without sterile base, drying very hard. *Peridium* single, dirty white, drying brown (between Sayal and Verona Brown) and very rugulose, tough and separating from the gleba. *Gleba* drying pale brown (Avellaneous to Wood Brown), hard, consisting of gelatinous tromal plates anastomosed to form cellular to labyrinthiform cavities and more or less radiating from the branches of the central columella. *Tromal plates* gelatinous, of fine, parallel, wavy hyphae, 35-100  $\mu$  diam. Cavities filled with spores. *Basidia* not seen, apparently soon shrivelling up. *Spores* broadly oval, truncate at the base where remains of the sterigmata often persist as short prongs, finely verrucose, surrounded by a gelatinous sheath, pale ochraceous brown, 12-15  $\times$  8-10  $\mu$  diam.

*Habitat*: in leaf mould at foot of tree.

*Distribution*: South Africa.

*Specimens examined*: Salisbury, S. Rhodesia, March 1920, F. Eyles 2530 (S. Rh. 3826) as *Hymenogaster radiatus* Lloyd 17795.

**Excluded Species.**

**Protubera africana** Lloyd.

Mycological Writings 6 (1920) 987.

Verwoerd, South African Journ. Sci. 22 (1925) 163.

An examination of part of the type collection, *Duthie* 233 (v. d. Byl 2094; Lloyd Myc. Coll. 22143) 31418, found in damp clayey soil on the Papegaaisberg at Stellenbosch, C.P., June 1919, kindly donated by the collector to the National Herbarium, indicated that as suggested by G. H. Cunningham (Gastero. 1944 : 213) the species was based on a phalloid egg. Further collections from the same area, attributed to Dr. Duthie, included in the van der Byl herbarium under the numbers 2501 (July 1927) and 2331 (June 1923) are probably the same fungus. These specimens were not found by me when going through Dr. v. d. Byl's Gasteromycetes.

**SECOTIACEAE** Tulasne.

Annales des Sciences Naturelles Ser. III, 4 (1945) 176.

emended Ed. Fischer, Naturliche Pflanzenfamilien 1\*\*, 1 (1900) 299.

Plants finally partly or entirely epigaeous, consisting of a subglobose, oval, obovate or conical peridium borne on a usually well-developed stem. Gleba compact, composed of numerous, permanent tromal plates, which arise from the peridium only or also from the columella and either anastomose frequently to form cellular or labyrinthiform cavities lined with spore-bearing hymenium, or anastomose sparingly to form more or less radially arranged, sub-lamellate plates, or remain separate forming vertically suspended, tooth-like processes of which all the surfaces are covered with spore-bearing hymenium. Stem long or short, solid, stuffed or hollow, prolonged as a columella through the gleba to the apex, where it often expands laterally and merges with the peridium; attached to the substratum

by one or several stout, mycelial, cord-like structures. Basidia 1-4-spored, sterigmate, soon shrivelling. Cystidia occasionally present. Spores globose, subglobose, broadly oval, obovate, smooth or rough, byaline or coloured.

Four genera have been included in this family, namely *Secotium*, *Macowanites*, *Polyplodium* and *Gyrophragmium*. The two latter genera do not seem altogether in place in this family but, other than creating a new family for which there does not seem sufficient justification, it is difficult to know where else to put them. Some justification for this arrangement may be found if the nature of the gleba in the four genera is taken into consideration. In *Secotium* and *Macowanites* it is typically, in part at least, long cellular, but in *Secotium agaricoides* and *S. obtusum* it approaches the lamellate form with the apical plates suspended vertically from the apex of the peridium. If one considers the separate tooth-like plates of *Polyplodium* and *Gyrophragmium* as interrupted, lamellate plates, the lamellate *Secotiums* might be considered as a transitional stage between *Secotium* and *Polyplodium*.

#### Key to the Genera.

Peridium stipitate, stem prolonged through the gleba as a simple, well defined columella.

Tramal plates sparingly to frequently anastomosed to form cavities lined with spore-bearing hymenium.

Gleba entirely covered by the peridium.....

1. *Secotium*.

Gleba partially covered by the peridium; basal part decurrent on stem and projecting below the margin of the peridium.....

2. *Macowanites*.

Tramal plates not anastomosed but separate, tooth-like, vertically suspended from the apex of the peridium, exposed at maturity.

Plants massive, with large, erect volva at junction between columella and stem-like base.....

3. *Polyplodium*.

Plants slender with small, volva-like structure at base of stem.....

4. *Gyrophragmium*.

#### 1. SECOTIUM G. Kunze.

*Secotium*, eine neue Gattung der Gasteromycetes Trichogastres in Flora 23 (1840) 321.

Fischer, Nat. Pflanz., 7a (1933) 112; Verwoerd, Ann. Univ. Stell. 3 (1925) 16; Cunningham, Gastero. (1933) 77.

*Endoptychum* Czern., Bull. Soc. Imp. Nat. Moscou 18 (1845) 146.

*Elasmomyces* Cav., Malpighia 11 (1897) 414.

*Artymenium* Berk. in litt.

Type Species: *Secotium Gueinzii* Kunze.

Plants finally epigeous, consisting of a solid, fleshy then punky, subglobose, oval conical, irregular peridium borne on a well-developed stipe. Peridium smooth, areolate or warded, enclosing the gleba, margin at first adpressed to the stipe, finally usually breaking away when smooth, lacerated or splitting. Dehiscence by separation of the margin of the peridium from the stem, followed by gradual disintegration. Stem central, long or short, traversing the gleba up to the apex as a simple, unbranched columella, either penetrating the gleba or at some distance from it, expanded laterally at the apex to merge with the peridium. Gleba cellular to sublamellate, composed of subglobose or elongated cavities formed by sparingly to frequently anastomosing permanent tramal plates, firmly attached to all parts of the peridium, the lamellate condition being reached in the case of sparingly anastomosed tramal plates. Basidia 4-spored. Spores smooth, subglobose, broadly oval or slightly obovate.

The taxonomic position of this genus has given rise to much difference of opinion. de Toni (Sacc. Syll. Fung. 7, 1888 : 52) placed it in the Podaxineae under the Lycoperdaceae. Fischer (Nat. Pflanz. 1\*\*, 1, 1900 : 300) first included it with *Macowanites*, *Gyrophragmium* and *Polyplodium* in the Secotiaceae under the Hymenogastrineae, but subsequently (l.c. 7a, 1933 : 112) transferred the family Secotiaceae to the sub-order Podaxineae. Dodge on the other hand (Comp. Morph. Fungi, 1928 : 493) included it with *Podaxis* and *Hysterangium* in the Hysterangiaceae, while Conard (Mycologia 7, 1915 : 94) considered that it should be included in the Agaricaceae. Finally Cunningham (l.c. p. 78) whose arrangement is here followed, has placed *Secotium* in the family Secotiaceae of the order Hymenogastrales on the grounds that it most nearly resembles members of this order, being separated only by the presence of a definite stem.

Thirty-three species have been described for this genus, but of these only two have so far been found in South Africa.

#### Key to the Species.

Gleba cellular. Plants large, up to 13 cm. high.....	1. <i>S. Gueinzii</i> .
Gleba sub-lamellate. Plants small, up to 4 cm. high.....	2. <i>S. obtusum</i> .

#### 1. *Secotium Gueinzii* Kunze. [Plate II, fig. 1, 2. Plate III, fig. 1.]

*Secotium*, eine neue Gattung der Gasteromycetes Trichogastres in Flora oder Bot. Zeitt. 23 (1840) 321.

Berkeley in Hooker's Journ. Bot. 2 (1843) 200; Corda, Icon. 6 (1854) 29, Pl. VI, fig. 10-18; Sacc. Syll. Fung. 7 (1888) 52.

Plant sub-hemispherical, depressed globose or ovate, apex often depressed, 5-12 cm. wide, 3-13 cm. high without stipe, whitish, smooth or obscurely floccose, wrinkled at the base, areolate in the apical portion, originally united to the stipe, later breaking away either entirely or partially. In the latter case the stipe may be pulled to one side before finally becoming free or in some cases part of the peridium remains permanently attached to the stipe. When the peridium does not break away entirely from the stem, it remains on the ground, not raised on its stalk at all. The fruit body gradually disintegrates, the process being hastened by gnawing insects and by rain. *Peridium* thin, white, corky-membranaceous to floccose at base. Stipe concolorous, up to 6 cm. long, 1.5 cm. thick at apex and up to 2.5 cm. thick at base where it is enlarged, solid, punky, attached to the substratum by a substantial mycelial cord, prolonged through the centre of the gleba as a cylindrical columella, reaching the apex, where it expands laterally and merges with the peridium. Lower part of the columella free from the gleba but the upper part narrowing and penetrating it. Base of stem proper smooth or with floccose rings—the remains of the peridium left when the latter breaks away from the stem. *Gleba* fuscous to pale olivaceous-brown, cellular, composed of irregular, elongated cavities formed by anastomosed trama plates. *Basidia* 4-spored. *Spores* smooth, subglobose, broadly oval or slightly obovate when apiculate or shortly pedicellate, with one large guttule,  $11.9-13.6 \times 8.5-10.2 \mu$ , tinted brown with dark episporae.

*Habitat* : in open ground.

*Distribution* : South Africa.

*Specimens examined* : Brakenfel nr. Belville, C.P., Dec. 1932, *J. P. H. Acocks* (E. L. Stephens 159); Nov. 1933 (E. L. Stephens 307); Stikland, C.P., May 1933 *J. P. H. Acocks* (E. L. Stephens 230); nr. Schuur's Drift, Capetown-Malmesbury road, April-June 1940, *J. W. Mathews & E. L. Stephens* (E. L. Stephens 528) 35531; ? Signal Hill, Capetown, May 1914, *W. J. Foley* (S.A. Museum).

*Specimens not seen* : Cape Flats, C.P., 1839, *Gueinzius*; Uitenhage, 1839, *Zeyher*.

I am indebted to Miss E. L. Stephens for the specimens from which the above description was made and for the information about the final disintegration of the plant.

This plant is distinguished by its large size, white colour, areolate peridium and cellular gleba.

**2. *Secotium obtusum* Lloyd.** [Plate III, fig. 2.]

in Stevenson and Cash, The new fungus names proposed by C. G. Lloyd, (1936) 193.

*Peridium* 6 mm.-5 cm. wide, 6 mm.-4 cm. high without stipe, broadly oval or irregularly obovate, usually becoming deeply hemispherical with rounded or truncate base or occasionally expanded, whitish, grey, pale ochraceous or sometimes tinged with ochraceous, more or less smooth at first, becoming slightly to deeply wrinkled, areolate or less often the outer layer cracking into large, thick, imbricate warts; 2-layered, inner layer thin, outer layer thin to moderately thick, tough or brittle, originally enveloping the whole plant, later breaking away completely or sometimes only partially from the base, exposing the very short, usually bulbous stipe. Margin of peridium rounded, entire, lacerated or splitting longitudinally into up to 9 fissures which extend up to two-thirds of the height of the peridium. *Stipe* whitish, very short, scarcely visible, usually bulbous, attached by a stout mycelial cord, traversing the centre of the gleba to the apex as a columella which is free from the gleba. *Columella* cylindrical, thin or thick, in the latter case internally fibrous-cellular, reddish brown in colour. In the case of lop-sided specimens, the columella may be angled. *Gleba* creamy white then greyish fuscous, in the early stages consisting of long irregular, sinuously walled chambers which become lengthened and narrowed until the tramal plates become closely compacted and sub-lamellate. The latter arise from all parts of the inner surface of the peridium and, when mature, radiate from the latter towards the centre, the ends terminating near the columella in an almost continuous surface. *Tramal plates* up to 1.5 cm. long, 9 mm. wide, length depending on the shape of the peridium and the position of the columella, pale greyish-brown to ochraceous. *Spores* attached to all surfaces of the tramal plates, at maturity forming a brown layer which is detachable from the plates and gives the gleba a laminated appearance of alternate brown spore layers and paler tramal plates; brown, globose or sub-globose, often apiculate or shortly pedicellate, obscurely sparsely verrucose, 5-6  $\mu$  diam.

*Habitat* : in open ground.

*Distribution* : South Africa.

*Specimens examined* : Knapdaar nr. Burghersdorp, C.P., April 1924, *Gideon Joubert*, 18113, type; in grey silt, Cornforth Hill, Barkly West, C.P., June 1936, *J. P. H. Acocks* 409, 28644.

This species is distinguished by its oval shape, greyish-fuscous, sub-lamellate gleba and brown spores. It differs from *S. agaricoides*, which it resembles externally, in shape, in the colour of the gleba and the size of the spores.

**2. MACOWANITES** Kalchbrenner.

*Hedwigia* 15 (Aug. 1876) 115.

Kalchbrenner, *Grevillea* 10 (1882) 107; *Sacc. Syll. Fung.* 7 (1888) 179; Fischer, *Nat. Pflanz.* 1, 1\*\* (1899) 299, 7a (1933) 11; Zeller & Dodge, *Ann. Mo. Bot.* *Gard.* 6 (1919) 56, 23 (1936) 636; Verwoerd, *S. Afr. Journ. Sci.* 22 (1925) 166.

*Macowanias* Kalchbrenner, *Gard. Chron. N.S.* 5 (June 1876) 785, non *Macowanias* Oliver, *Hooker Icon.* 1 (1870) 49.

*Hypochanum* Kalchbr., *Gard. Chron. N.S.* 6 (July 1876) 140.

Type Species : *Macowanites agaricinus* Kalchbr.

Peridium epigean, subhemispherical when young, pileate at maturity, fleshy, stipitate. Stipe prolonged through the centre of the gleba to the apex as a columella. Gleba arising from the stipe as well as from the peridium, decurrent, projecting below the margin of the peridium, composed of unequal, subglobose to elongated cavities formed by anastomosed tramal plates, the basal cavities open to the outside, finally more or less radiating from the stipe. Basidia 2-spored. Spores large, globose, echinulate.

This genus is probably monotypic and endemic to South Africa and, as far as is known, is represented by a single collection of possibly one specimen only, which was distributed to several herbaria in the form of slices.

In Transactions of the British Mycological Society 25 (1942) 334, J. Ramsbottom points out that *Hypochanum* is the valid name for this genus on the grounds of priority but proposes that *Macowanites* (with *M. agaricinus* as type) be conserved because of general usage against *Hypochanum*.

The systematic position of the fungus is uncertain and until fresh specimens and especially young stages of the fungus are available for study, cannot be established. The decision to place the genus tentatively in the Secotiaceae has been based on Kalchbrenner's description, which states that the plant is stipitate, the stipe being prolonged to the apex of the peridium in columella-fashion, a character shared by all members of this family, and that the gleba is composed of hymenial cavities elongated at the base where they are decurrent and project below the peridium, their apertures being open to the air.

G. H. Cunningham (Gastero. 1944 : 77) suggests that *Macowanites* may be based on a species of *Hydnangium* and in view of the fact that in two of the four slices of specimens available for study there is an indication of a fine, branched columella, this suggestion should be kept in mind. In the meantime it is impossible to come to any decision in the matter.

**Macowanites agaricinus** Kalchbrenner. [Plate IV, fig. 1.]

*Hedwigia* 15 (1876) 115, fig. c.

Kalchbrenner, *Grevillea* 10 (1882) 107; de Toni, *Sacc. Syll. Fung.* 7 (1888) 179;

Lloyd, *Myc. Writ.* 7 (1923) 1198; Zeller & Dodge, *Ann. Mo. Bot. Gard.* 6 (1919) 58, 23 (1936) 636; Verwoerd, *S. Afr. Journ. Sci.* 22 (1925) 166.

*Macowania agaricinus* Kalchbr., *Gard. Chron. N.S.* 5 (1876) 785.

Plants hemispherical, 3·8 cm. wide, 3·5 cm. high, stipitate, fleshy, becoming wrinkled, dingy brown (Snuff Brown). *Peridium* 1-layered, thin, 1 mm. or less thick. *Stipe* about 1 cm. thick, 1·5 cm. long up to the base of the gleba, "white with cut surface, Cartridge-Buff or a little darker below", prolonged through the gleba up to the apex as a columella. *Gleba* tawny (between Tawny and Russet) arising from the columella as well as from the peridium, compact, composed of unequal, subglobose to elongated cavities formed by anastomosing tramal plates, more or less radiating from the columella, the basal cavities larger, more elongated, decurrent, open to the outside, projecting below the margin of the peridium. *Tramal Plates* 17–34  $\mu$  diam., strand-like, without evident palisade hymenial layer. *Basidia* 1–2-spored, apparently soon shrivelling up, the sterigmata finally thread-like structures. *Spores* large, globose, pale olivaceous to olivaceous brown, grossly echinulate, 15·3–18·7  $\mu$  diam., average size 17  $\mu$ .

*Habitat* : amongst grass at foot of trees.

*Distribution* : South Africa, rare.

*Specimens examined* : at foot of Acacia tree, Somerset East, 1876, *MacOwan* 1211 (S.A.M. 35048) 22087.

*Specimens not seen* : *MacOwan* 1211 at Kew, Upsala and a fragment of the Kew specimen in New York Bot. Gard. Herb.

The species is represented by about six slices of the type specimen—three in the South African Museum, one in the National Herbarium, Pretoria, one at Kew, one at Upsala and a corner of the Kew specimen in the New York Botanic Gardens Herbarium. Two water colour sketches at Kew, reproduced in Gardener's Chronicle N.S. 5 (1876) 785, fig. 141, under the original name of *Macowanias agaricina* are the only known illustrations of the fungus. The above description was made partly from the four slices in South African herbaria and partly from Zeller and Dodge's description (l.c.) of the sketches at Kew. None of these slices shows any stipe or exposed glebal cavities as described and illustrated by Kalchbrenner, although one slice shows two basal glebal lobes. Two of the slices are entirely free of columella but the other two show indications of an inconspicuous branched columella. It is doubtful if any one of the slices examined was cut through the centre of the plant. The presence of columella-like tissue in at least two specimens supports Cunningham's suggestion (Gastero. 1944 : 77) that the genus may have been based on a *Hydnangium*. It is not clear, however, how one could reconcile the exposed glebal cavities—if such actually existed—with the latter genus. No 2-spored basidium such as Kalchbrenner illustrated was seen by me. In most cases there appeared to be only one spore, attached by a lax, thread-like sterigma. Occasionally pairs of spores, one on top of another, suggested that they might originate from one basidium, but in such cases the basidium was never actually seen.

Two other species of *Macowanites* have been described—*M. echinosporus* Zeller & Dodge (Ann. Mo. Bot. Gard. 6, 1919 : 57) and *M. magnus* Parks, (Ann. Mo. Bot. Gard. 22, 1935 : 369). Ed. Fischer (Nat. Pflanz. 7a, 1933 : 111) however, considers that the former is more nearly related to 'Arcangeliella' on account of its lactiferous vessels and non-percurrent columella, and Zeller & Dodge (l.c. 23, 1936 : 638) suggest that the latter may be considered close to the same genus on account of the lactiferous ducts in the sterile tissue. G. H. Cunningham (Gastero. 1944) treats *Arcangeliella* as a synonym of *Hydnangium*, on the grounds that lactiferous ducts, on which the genus was erected, are not consistently present and therefore do not constitute a generic character. In the sense of Cunningham, therefore, *M. echinosporus* and *M. magnus* would probably be considered *Hydnangium*.

### POLYPLOCIUM Berkeley and GYROPHRAGMIUM Montagne.

The systematic position of these two nearly related, or possibly synonymous genera, is not certain and has given rise to much difference of opinion. Berkeley (Hooker's Journ. Bot. 2, 1943 : 202) considered that his genus *Polyplocium* belonged to the Hymenomycetes and was closely related to *Boletus*. Fries (Epicr. 1, 1874 : 241) named two specimens sent to him by Montagne *Montagnites Dunali* and *M. Candollii* respectively and referred them to the Agaricaceae. Montagne subsequently erected his new genus *Gyrophragmium* on the specimen of *M. Dunali* on the grounds that it did not belong to the Agaricaceae but to the Gasteromycetes. de Toni (Sacc. Syll. Fung. 7, 1888 : 55) placed both *Polyplocium* and *Gyrophragmium* in the Podaxineae which he included in the Lycoperdaceae. Ed. Fischer (Nat. Pflanz. 1, 1\*\*, 1900 : 203 and 7a, 1933 : 115) included the two genera in Secotiaceae. Finally Lloyd (Myc. Notes 18, 1904 : 195) expressed the opinion that *Gyrophragmium* (with which he included *Polyplocium* as a synonym) was closer to the Agarics than to the Gasteromycetes, adding "it is a connecting link between the two, passing on one hand through *Montagnites* to *Coprinus* and on the other through *Secotium* to the true Gasteromycetes".

Since the balance of opinion appears to favour the inclusion of *Polyplocium* and *Gyrophragmium* in the Gasteromycetes rather than in the Hymenomycetes, it is proposed to include them in the present work. Following Cunningham's division of the orders and families of the Gasteromycetes, they would appear to be most nearly related to members of the Secotiaceae.

It is held by some that *Polyplodium* and *Gyrophragmium* are synonyms. It is impossible to pass an opinion on this point without having seen overseas specimens and the early stages of both forms of plants, but, judging from South African specimens, there seems some justification for keeping the two genera separate and it has therefore been decided to do so. *Polyplodium* has been reserved for the more massive type of plant in which a large, erect, cup-shaped, volva-like structure—originally the base of the peridium—is found on the thickened part of the fusiform stem, i.e. at the base of the columella, and the apex of the stemlike base, and *Gyrophragmium* for the slender type in which a small, dependent, floccose-membranaceous ring-like structure is found at the base of the columella (the origin of which is not clear) and a small volva-like structure at the base of the stem which is not found in *Polyplodium*. In the latter genus on the other hand, evident remains of the original universal volva are present both on the apex of the peridium and on the outside of the cup-shaped volva, which is not the case in *Gyrophragmium*.

Judging from his illustrations (reproduced by Ed. Fischer, *Nat. Pflanz.* 7a, 1933 : 115) Montagne appears to have included both types of plant in *Gyrophragmium*; Fig. 88a is that regarded as typical *Polyplodium*, while Fig. 88b is typical *Gyrophragmium* without the scaly rings usually found on the lower part of the stem. If the latter are, as held by Lloyd (l.c.) fragments of the original 'volva' then this must be of a very different texture and nature in the two plants.

### 3. POLYPLOCIUM Berkeley.

On two Hymenomycetous Fungi in Hooker's *London Journal of Botany* 2 (1843) 202.

Sacc. Syll. Fung. 7 (1888) 55; Lloyd, Myc. Writ. 1, Myc. Notes 18 (1904) 195;

Ed. Fisch. *Nat. Pflanz.* 7a (1933) 115; Verwoerd, Ann. Univ. Stell. 3 (1925) 15.

Type species: *Polyplodium inquinans* Berk.

Plants: upper part finally epigeous, stemlike base remaining buried in the substratum; consisting in the mature condition of a shallow, hemispherical pileate peridium supported on a well-developed stemlike base. Peridium 2-layered, originally enclosing the gleba. Exoperidium thick, areolate or consisting of large warts. Endoperidium thick and fleshy, finally thin, membranous and punky. Dehiscence by irregular circumscissile splitting around the apical portion, resulting in an apical pileate structure with vertically suspended tramal plates attached to the under-side and a large, cup-shaped volva-like structure attached to the stem. Stemlike base originally massive and fleshy, becoming much shrunken, punky and fusiform, the upper part prolonged through the centre of the gleba as a columella to the apex where it expands laterally to merge with the peridium. Gleba attached, in mature plants, to the under-side only of the pileate peridium, consisting of numerous, more or less vertically suspended, black, brittle, simple or forked, toothlike tramal plates which project beyond the margin of the peridium and are so tightly compacted as to form a seemingly continuous, fine daedaloid-like surface at the lower extremity. Spores attached to all surfaces of the tramal plates. Basidia probably 4-spored. Spores oval, brown, smooth.

This plant was first collected by Burke and Zeyher on the banks of the Orange River in what was then the Cape Colony; Zeyher sent a single specimen to Berkeley, who in 1843 erected a new genus and species on it—*Polyplodium inquinans*. The plant was not seen again until 1919, nearly eighty years later, when Dr. I. B. Pole Evans found several more specimens on a termite heap at Vryburg, C.P., in an immature condition. During the following three years, four more collections were made, two by the same collector and two by Mr. Gideon Joubert—a farmer-collector of many interesting fungi. No further specimens were found after 1921 until just recently when Mr. J. P. H. Acocks came across two exceptionally fine, mature plants.

**Polyplocium inquinans** Berkeley. [Plate V, fig. 1; Plate VI, fig. 1, 2; Plate VII; Plate VIII.]

Hooker's London Journal of Botany 2 (1843) 203; Sacc. Syll. Fung. 7 (1888) 145; Lloyd, Myc. Writ. 1, Myc. Notes 7 (1901) 69; Myc. Notes 18 (1904) 195; Fischer, Nat. Pflanz. 70 (1933) 115.

*Gyrophragmium inquinans* (Berk.) Lloyd, Myc. Writ. 1, Myc. Notes 18 (1904) 197.

*Immature plant* (Plate VI fig. 1.) : 22 cm. long, 11 cm. wide, a massive, solid, fleshy, dirty white, club-shaped structure, smooth except at the apex where irregularly areolate to sub-warty. The enlarged apical portion contains the gleba, while the basal part constitutes a massive, stemlike base. The centre of the gleba is traversed right up to the apex by a cylindrical columella—the prolongation of the central part of the stemlike base—while the whole head is enveloped by a universal volva formed by the prolongation of the marginal part of the base from the level at which the central part enters the glebal cavity as a columella. Gleba consisting of closely compacted, irregular, black tramal plates, arising both from the underside of the apex of the glebal chamber and from the entire length of the columella. In the former case the tramal plates are long and hang vertically almost to the base of the cavity, while in the latter they are shorter and more or less horizontal to oblique towards the apex (described from one specimen).

*Mature Plant* up to 19 cm. high, 7.5 cm. wide, consisting of a two-layered, hemispherical, pileate peridium supported on a well-developed, fusiform stalk, the lower portion of which remains embedded in the substratum. *Exoperidium* dirty white to greyish brown, areolate or consisting of thick, flattened to pyramidal, persistent or caducous warts—the remains of the volva-like structure originally enveloping the peridium. *Endoperidium* thick at first, finally membranous, punky, splitting circumscissilely around the apical portion (Plate VII) resulting, due to the prolongation of the columella, in an apical, pileate, stalked structure and a large, cup-shaped volva-like structure attached to the thickened area at the apex of the stemlike base. *Stem* fusiform, up to 19 cm. long inclusive of the columella, 1.5-3.5 cm. wide at the thickest part, i.e. about two-thirds from the base, dirty white, fibrous, punky in the irregular, attenuated basal portion, sulcate above the volva. *Volva* up to 7 cm. wide at the margin, irregular, large, tough, membranous, brittle, with or without the exoperidial warts on the outside, forming an erect but spreading cup-shaped collar on the swollen part of the stem. *Gleba* consisting of closely packed, sub-cylindrical to narrow tramal plates which hang vertically from the underside of the pileate structure and project up to 1.5 cm. below the margin. The plates which were originally present on the columella apparently separate from the latter and fall away as the plant matures. *Tramal plates* up to 3 cm. long and 5 mm. wide in the young stage, but drying shorter and thinner, black, brittle, very thin, with minute, longitudinally projecting wings of the same texture. The latter fit closely into others of adjacent plates, forming an almost continuous, irregular, gyrose surface at the lower extremity of the plates. Berkeley compared this surface to the porous surface of *Boletus*. At maturity the plates separate from each other and resemble irregularly twisted, crinkled, tooth-like processes. *Basidia* probably 4-spored, apparently soon shrivelling. *Spores* attached to all surfaces of the tramal plates, typically broadly oval, occasionally globose or truncate, smooth, dark brown, sometimes very shortly pedicellate,  $5.2-10.2 \times 5.2-6.8 \mu$ , common size  $8.5 \times 6 \mu$ .

*Habitat* : on termite heaps.

*Distribution* : North and South Africa; North America.

*Specimens examined* : Armoedsvlakte, Vryburg, C.P., March 1919, *I. B. Pole Evans*, 11856; Malcomess, Knapdaar, nr. Burghersdorp, March 1921, *Gideon Joubert*, 14505, Nov. 1936, 28739 Lake Chrissie, Tvl., March, 1921, *I B. Pole Evans*, 18115, on termite heaps with *Podaxis pistillaris*.

*Specimens not seen* : On banks of Orange River, *Burke and Zeyher*, type, South Africa, without locality Kew.

The distinguishing features of this species are the pileate peridium with its closely compacted, black tramal plates vertically suspended from the underside, the large volva-like structure left on the enlarged portion of the fusiform stem at the base of the 'columella', after the endoperidium has dehisced around the apical portion and the oval spores. It differs from *Gyrophragmium Delilei*, as here interpreted, in the more massive stature, the large volva-like structure situated at the apex of the stemlike base and the shape of the spores.

Although the type specimen has not been available for examination, there seems little doubt that the plant dealt with above is the same as that described and illustrated by Berkeley (l.c.) as *Polyplodium inquinans* from Zeyher's South African specimen, since, with the exception of the capillitium threads, which were not found in the above collections and which Berkeley possibly confused with fragments of the tramal plates, the plants seem identical in every respect.

#### 4. **GYROPHRAGMIUM** Montagne.

*Annales des Sciences naturelles*, 2 Sér. Bot. 20 (1843) 77.

Ed. Fischer, *Nat. Pflanz.* 1, 1\*\* (1900) 203, 7a (1933) 115.

Type Species : *Gyrophragmium Delilei* Mont.

Plants : upper part finally epigeous, lower portion of stem remaining submerged in the substratum ; consisting of a shallow-hemispherical, pileate structure with black, vertically suspended, tooth-like tramal plates attached to the underside, and supported on a well-developed stem. Peridium thin, membranous, probably 2-layered, originally enclosing the gleba, dehiscing circumscissilely at the margin of the 'pileus'. Stalk proportionately long and slender, the upper part originally prolonged as a columella through the centre of the gleba to the apex, where it expands laterally to merge with the endoperidium ; the lower two-thirds submerged, usually clothed with successive rows of floccose, scaly rings, the uppermost of which is larger than the others and is dependent against the stem, while the base is surrounded by a small volva-like structure of the same texture and colour. Gleba consisting of closely compacted, brittle, separate, vertically suspended, tooth-like tramal plates attached to the whole underside of the apex of the peridium, except in the immediate vicinity of the central columella. Basidia probably 4-spored. Spores attached to all surfaces of the tramal plates, globose, dark brown, smooth.

Five species have been described for this genus, but according to Ed. Fischer, l.c., probably only the type species is valid. It is represented in the National Herbarium by four collections only, all found in the Griqualand West area, where much of the country is sandy, by Mr. J. P. H. Acocks. Unfortunately only the fully mature plant has been found up to the present time.

*Gyrophragmium* has sometimes been confused with *Montagnites*. Fries [Epier. 1 (1874) 241] was the first to make this error, when he called Montagne's subsequently named *Gyrophragmium*, *Montagnites Dunalii*. In that case the two genera were found together and it is interesting to note that in the case of South African collections most of the *M. Candollei* specimens have been found in the same areas as *G. Delilei*. There is a certain superficial resemblance between the two in stature, position, colour and texture of gills and the presence of a small volva at the base of the stem ; but they differ mainly in the fact that in *Montagnites* the gills are lamellate and radiate from an expansion of the apex of the stipe, whereas in *Gyrophragmium* the tramal plates are separate and tooth-like, though sometimes seemingly arranged in parallel lines, and are attached to the apex of the peridium from which they hang vertically.

**Gyrophragmium Delilei** Montagne. [Plate IV, fig. 2; Plate IX.]

Flore d'Algerie 1 (1846-1849) 369, t. 21, f. 2 pro parte.

Lloyd, Myc. Writ. 1, Myc. Notes 7 (1901) 68, Myc. Notes 18 (1904) 196; Ed. Fischer, Nat. Pflanz. 7a (1933) 115, fig. 88b.

*Montagnea Delilei* Fries in litt.

*Scleroderma texense* Berk., N. Am. Fungi in Lond. Journ. Bot. (1845) 308.

*Secotium texense* Berk. & Curt., N. Am. Fungi in Grev. 2 (1873) 34.

*Agaricus ocreatus* Delil. inser. Fr. Epicr. 1 (1874) 241.

*Montagnites Dunalii* Fr., Epicr. 1 (1874) 241.

*Gyrophragmium texense* (B. & C.) Mass., Grev. 19 (1890-1891) 96.

*G. argentinum* Speg., Fung. Arg. novi v. crit. (1899) 185.

*Secotium decipiens* Peck.

*Gyrophragmium decipiens* Lloyd, Myc. Writ. 1, Myc. Notes 6 (1901) 62.

*Podaxon strobilaceus* Copeland, Ann. Myc. 2 (1904) 4.

Mature plant consisting of a small pileate peridium to the underside of which are attached numerous black, tooth-like, vertically suspended tramal plates, supported on a relatively long, slender, well-developed stalk. *Peridium* shallow hemispherical, 3-3.5 cm. wide, 1.5-2 cm. high, pale to dark greyish brown, smooth or transversely wrinkled at the margin, plane or slightly to strongly umboinate, margin even, becoming lacerate. *Stipe* 10-20 cm. long, 0.7-2.2 cm. wide, the upper portion dirty white to greyish, deeply sulcate, punky, attenuated towards the apex, representing a prolongation of the basal stem which in the early stages traverses the centre of the gleba to the apex as a columella; the lower two-thirds dirty white to cream tinged with yellow ochre, punky, sometimes becoming hollow, striate and fibrillose when dry, smooth or usually clothed with 2-6 successive rows of flattened to spreading, lacerated, floccose, scaly rings, 7 mm. to 2-5 cm. apart, the lowest ring forming a volva-like structure at the base of the stem, while the top ring which is larger, more regular and dependent against the stem, resembles an agaric ring. *Gleba* consisting of closely compacted, separate, sub-cylindrical or more or less flattened, tooth-like tramal plates, attached singly or in small groups, irregularly or in sub-parallel lines, to the underside of the peridium, hanging vertically downwards to the level of, or slightly below the margin. *Tramal plates* 5-6 mm. long, 1-2 mm. wide, brittle, black, straight or, at the margin, curved towards the centre, sometimes forked at the tips, with minute, longitudinal, wing-like expansions of the same texture, closely compacted together as in *Polyplodium*. *Basidia* probably 4-spored, apparently soon shrivelling up. *Spores* borne on all surfaces of the tramal plates, smooth, brown, typically globose, 5-7  $\mu$  diam., sometimes apiculate or very short pedicellate.

*Habitat* : in sandy places.

*Distribution* : North and South Africa; North and South America; Asia; Europe.

*Specimens examined* : in red sand, Kimberley Distr., Griqualand West, March 1936, *J. P. H. Acocks*, 28624; near de Beer's Mine, Kimberley, May 1936, *J. P. H. Acocks* 336, (Kew) 28635; Olifantshoek Rd., Kuruman Distr., C.P., June 1936, *J. P. H. Acocks* 405, 28640, Kew; Knockbarragh, Barkly West, C.P., May 1936, *J. P. H. Acocks* 330, 28634.

*Specimens not seen* : Brackenfel, Belville, *J. P. H. Acocks*, Kew.

The South African form of this species is recognised by its slender stature, consisting of a small, pileate peridium supported on a long, slender stalk, the presence of the lower two-thirds of the stem of successive, floccose, membranous rings, the lowest of which forms a volva-like structure at the base of the stem, while the top one resembles a dependent ring of an agaric, and the globose spores. Unfortunately no early stage of the plant has

been seen by me and the significance of the small volva-like structure at the base of the stem and the agaric-like ring at the top of the subterranean part is not clear. The size and appearance of the latter suggest that it may have originally been united to the margin of the "pileus", thus forming the lower part of the peridium as in *Polyplodium*. According to Lloyd, the young plants are enclosed in a 'volva' which breaks irregularly as the plant grows, usually remaining as a kind of 'volva-cup' at the base of the plant in the European form and generally breaking loose from the base of the plant in the American form. He considered that the scaly rings on the stem are fragments of the 'volva'.

The European and American species appear to include a wide range of forms from the slender type found in South Africa and the Argentine to the massive type approaching *Polyplodium* found in Europe and America. *Gyrophragmium texense* for instance, has the stature of *Polyplodium* but a stem more like *Gyrophragmium*. *G. decipiens* likewise has the stature of *Polyplodium*, but, according to Lloyd, i.e., the volva does not usually form a cup, but breaks away from the base of the stem. *G. argentinum* appears to be typical of the South African form, but *Podaxon strobilaceus* has characters of both. In this connection, the similarity of Copeland's *Battarea arenicola* [Ann. Myc. 2 (1904) 2, Plate 1, fig. 6] both in description and illustrations, to the slender form of *G. Delilei* is striking.

### PHALLALES.

The phalloids are recognised by their bizarre shapes, vivid red and orange colours, brittle, spongy texture, their ephemeral nature and usually overpowering foetid smell. They are world-wide in distribution, appearing overnight, usually after a wet spell, and collapsing after a few hours. The foetid smell serves to attract certain flies which aid in the dissemination of the spores. All forms of this order are characterised by the presence of an egg-like structure called the peridium, which splits at the apex to allow of the development from its centre of a spore-bearing structure known as the receptacle. The remains of the peridium left at the base of the receptacle are called the volva. The detailed characters of the order are as follows:—

Peridium usually of 3 layers (2 in one family), an outer, tough, membranous layer—the exoperidium, a middle gelatinous layer—the mesoperidium—and an inner delicate membrane—the endoperidium—which encloses the spore-bearing receptacle. Receptacle loosely pseudo-parenchymatous, turgid and brittle, stipitate or non-stipitate, giving rise to one or more cellular or tubular columns and/or to a hollow, spherical, clathrate or latticed structure. Spore-mass mucilaginous, foetid, olive or brownish green, borne on some portion of the surface of the receptacle. Spores usually small, tinted, smooth and bluntly elliptical. "Basidia 4-8-spored."

Cunningham extends the order to include three families, erecting a special family—*Claustulaceae*—for the genus *Claustula* on account of its indehiscent receptacle and lack of mucilage. Fischer refers *Claustula* to the *Clathraceae*.

#### 1. *Claustulaceae*:

Receptacle an obovate, indehiscent, hollow sphere, the spore mass lining the inner surface of the wall.

#### 2. *Phallaceae*:

Receptacle a simple, cylindrical, hollow stem, the spore mass borne directly on the apical portion or on a campanulate pileus attached to the apex.

#### 3. *Clathraceae*:

Receptacle forming a stipitate or sessile structure which is clathrate, columnar or of apically united connivent or free arms arising from the apex of a stemlike base. Spore mass borne on some portion of the receptacle, usually the arms.

Of the above families only the Phallaceae and Clathraceae are represented in Southern Africa, the former by the genera *Mutinus*, *Itajahya*, *Phallus* and *Dictyophora* and the latter by *Linderiella*, *Anthurus*, *Lysurus*, *Clathrus* and *Kalchbrennera*. *Aseroe* and *Colus* have been recorded from this country but their occurrence seems doubtful.

As far as our records show *Mutinus* and *Anthurus* are confined to the south-western Cape, *Itajahya* to the Transvaal and Orange Free State and *Linderiella* to Angola. The remaining species appear to be fairly evenly distributed.

Our knowledge of the South African phalloids and their distribution is very imperfect and it is quite possible that unrecorded species still exist. Apart from the coastal belt of the Cape Province with its temperate climate and winter rainfall, where these plants occur fairly regularly every winter, very little systematic collecting of phalloids has been done in any part of the country. Various native and other forest areas in subtropical parts with summer rainfall remain quite unexplored and should yield a rich harvest of such plants. Unfortunately such likely areas are off the beaten track and distances being very great, transport problems are often unsurmountable. Added to these difficulties is the brittle and ephemeral nature of the plants themselves which discourages private individuals from sending such specimens by post.

#### PHALLACEAE Corda.

Icones Fungorum 5 (1842) 29;

emend. Ed. Fischer, Natürlichen Pflanzenfamilien 1 (1900) 289.

Peridium globose, oval or ovate, consisting of three layers of which the middle one is finally gelatinous; splitting at the apex into irregular lobes on the expansion of the receptacle, at the base of which it remains collapsed as a volva. Receptacle hollow, cylindrical or fusiform, the wall consisting of one or several layers of cells. Spore mass borne externally on the modified apex of the stem or on a campanulate pileus attached to the apex; olive green or brownish olive green. Indusium present in one genus—*Dictyophora*. Spores elliptical, smooth, hyaline or tinted.

#### Key to the Genera (sec. Cunningham).

Spore mass borne directly on the upper part of the receptacle.

Spore mass covering the apical portion of the receptacle..... 1. ***Mutinus*.**  
 Spore mass forming a collar-like restriction below the inflated apex of the receptacle..... (*Staheliomyces*).  
 Spore mass covering a net-like pileus loosely attached to the upper part of the receptacle..... (*Floccomutinus*).

Spore mass borne on a campanulate pileus.

Indusium absent or only rudimentary.

- Pileus formed of radiate plates..... (*Aporophallus*).  
 Pileus formed of lamellate plates..... 2. ***Itajahya***.  
 Pileus externally rugulose, papillate or reticulate..... 3. ***Phallus***.
- Indusium present, well developed..... 4. ***Dictyophora***.

Of the seven genera included in the above key, four only occur in South Africa—*Mutinus*, *Itajahya*, *Phallus* and *Dictyophora*. Of the remainder, *Staheliomyces* occurs in British Guiana and the Malay Archipelago, *Floccomyces* in West Africa and *Aporophallus* in Brazil.

1. **MUTINUS** Fries.

*Summa Vegetabilium Scandinaviae*, Part 2 (1849) 434.

*Phallus* § *Cyanophallus* Fr., *Syst. Myc.* 2 (1822) 284.

*Cyanophallus* (Fr.) Corda, *Icon. Fung.* 6 (1854) 19.

*Corynites* Berk. et Curt., *Trans. Linn. Soc.* 21 (1855) 149.

*Jansia* Penz., *Ann. Jard. Bot. Buitenzorg* 16 (1899) 139.

Type Species: *Mutinus caninus* (Huds. ex Pers.) Fr.

*Peridium* spherical or oval, splitting at the apex into two or three lobes, finally collapsing against the base of the expanding receptacle. *Receptacle* simple, hollow, cylindrical or fusoid, perforated or not at the tip, cellular, usually some shade of red or pink, bearing the olive-green mucilaginous spore mass at or near the apical portion of the receptacle, which may be rough or smooth due to the presence of pulvinate or pseudo-parenchymatous processes. *Spores* cylindrical, smooth and tinted.

This genus is the most primitive of the family since the receptacle consists of a simple, hollow stalk which bears the spore mass directly on its apical portion.

*Distribution*: Europe; Asia; North and South America; Africa; India; Ceylon.

Following Cunningham, the species are divided on the nature of the spore-bearing part.

I. Spore-bearing part smooth or rugulose.

(*M. caninus*, *M. curtus*, *M. Curtisi*, *M. Fleischeri*, *M. xylogenus*.)

II. Spore-bearing part covered with irregular pseudoparenchymatous processes.

(*M. bambusinus*, *M. boreensis*.)

III. Spore-bearing part covered with digitate processes.

(*M. Pentzigi*, *M. proximus*.)

Of the 19 species described, Cunningham considers that only the above 9 are good species. To these *M. simplex* Lloyd, found in the forest area of Knysna, South Africa, might possibly be added. An examination of fresh plants is necessary to determine if this species can be separated from *M. Curtisi* (*M. elegans*). Of the species mentioned above, *M. Curtisi* is probably found in South Africa but the occurrence of *M. bambusinus* is extremely doubtful. Descriptions of all three species are however given to cover any uncertainty.

**Key to the Species.**

Spore-bearing part of receptacle smooth or rugulose.

Spore-bearing part not obviously differentiated from the rest of the stalk.

Receptacle tapering to a blunt point.....

***M. Curtisi*.**

Spore-bearing part more or less transversely rugulose. Receptacle more or less

equal, terminating in a blunt point.....

***M. simplex*.**

Spore-bearing part sharply differentiated from the stalk. Receptacle terminat-

ing in a sterile tip.....

***M. bambusinus*.**

1. ***Mutinus Curtisi* (Berk.) Ed. Fischer.** [Plate X, fig. 1.]

Versuch einer systematischen Übersicht über die bisher bekannten Phalloideen (Jahrb. d. Konigl. bot. Gartens zu Berlin IV, 1886: p.l.).

*Corynites Curtisi* Berk., Grev. 2 (1873) 34.

*Mutinus bovinus* Morgan, Journ. Cinn. Soc. Nat. Hist. 12 (1889) 147.

*M. elegans* (Mont.) Ed. Fischer.

*Peridium*  $3 \times 1.5$  cm., spherical then oval, white, splitting at the apex into several irregular lobes and finally collapsing against the developing receptacle; rooting by a strong, white, cord-like mycelium. *Receptacle* up to 8.5 cm. long, 1.9 cm. diam. at thickest part, tapering gradually to a blunt point; whitish in pickled specimens, probably some shade of red or pink in fresh plants; hollow, not perforate at the apex, slightly tubercular, more or less uniform, cellular, wall 1-2 chambered, cells opening inwards except at base where some are perforate on the outside; *spore-bearing* portion not obviously differentiated from the rest of the receptacle, apical, 4.5-5 cm. long, covered with olive-green slime. *Spores* about  $3.4 \times 2 \mu$  diam., tinted, oblong-cylindrical.

*Habitat*: on the ground.

*Distribution*: North America; Europe; South Africa.

*Specimens examined*: Rondebosch, C.P., June 1930, E. Loseby, 25461. These specimens, preserved in formalin with no notes attached, were probably identified by C. G. Lloyd, since all unknown specimens collected by the late Miss Loseby were, I think, sent to Lloyd for naming.

*Specimens not seen*: Rondebosch, June 1932, J. Acocks (E.L.S. 127) "with red tube".

It has been suggested (Fischer in Nat. Pflanz., 1933) that *M. simplex* probably takes the place of *M. Curtisi* in South Africa, but the specimens described above appear to be (as far as one can tell without examining fresh plants) *M. Curtisi* and not *M. simplex*.

This species is recognised by the shape of its receptacle which gradually tapers to a blunt point.

## 2. *Mutinus simplex* Lloyd.

Mycological Writings 6 (1919) 879, Fig. 1504.

*Peridium*  $2.2 \times 2$  cm., oval, whitish, splitting at apex into several segments; attached to soil by a stout, white, cord-like mycelium. *Receptacle* 7 cm. long, 1.9 cm. diam., bright red above, yellowish red towards base, rugulose, hollow, cellular, cells uniform, perforate towards inside, but continuous on outside; more or less equal, terminating in a blunt point. *Spore-bearing* part 2 cm. long, apical, more or less transversely rugulose (in dried specimens), covered with brownish-green slime. *Spores*  $4.5 \times 1.5 \mu$  diam., tinted, cylindrical, smooth.

*Habitat*: in indigenous bush.

*Distribution*: South Africa.

*Specimens examined*: Brenton, Knysna, A. V. Duthie 215, 31403; 31510 (E.L.S. 32) det. Lloyd.

*Specimens not seen*: Lloyd, Mycological collections No. 57856, Type, and 57850. It is not known to which of Dr. Duthie's collections these numbers refer.

Only two dried specimens were available for examination, one, *Duthie 215*, accompanied by a note that it was much shrunken and that the colour of the stalk was bright red, and the other, accompanied by a coloured outline sketch. The latter does not, however, show a transversely rugulose spore-bearing portion, so shrinkage may have been responsible for this appearance in the dried specimen. The measurements given were taken from the sketch.

According to Lloyd, this species is characterized by the lack of any differentiation between the spore-bearing portion and the rest of the receptacle, the uniform size of the cells of the latter, and the fact that these are continuous on the outside and perforate on the inside. *M. simplex* is said by Lloyd to differ from *M. elegans* (c.f. *M. Curtisi*) mainly in the shape of the receptacle.

3. ***Mutinus bambusinus* (Zoll.) Ed. Fischer.** [Plate X, fig. 2.]

Annales du Jardin Botanique de Buitenzorg 6 (1886) 30, tab. 4-5 fig.

Petch, Trans. Brit. Myc. Soc. 10 (1926) 272; Sacc. Syll. Fung. 7 (1888) 12.

*Phallus (Cyanophallus) bambusinus* Zoll., Syst. Verzeich. Indisch. Arch. 1842-48 gesammel (1854-1855).

*Peridium* 3.5 × 2 cm. diam., oval, sometimes covered above with a grey tomentose layer which splits into patches with growth of egg. *Receptacle* fusoid, up to 16 cm. high, 1.2 cm. diam., attached by a white, cord-like mycelium, purplish or red at apex, paler below, hollow, cellular, wall composed of single layer of large chambers the exterior walls of which are frequently perforate, the interior continuous. *Spore-bearing* part apical, except for 5 mm. of the tip which is sterile, pinkish, perforated or not and of the same structure as the stalk; variable in length, usually about half the total length, elongated conical, sharply differentiated from the stalk; diameter of head at junction with stalk up to 2 mm. greater than that of latter; dark red, dirty purple or brownish red with spore mass, bright crimson without; surface almost smooth to rough or granular due to the presence of irregular parenchymatous processes; spore mass dark olive, spread out in a thin patchy film when plant is fully developed. *Spores* cylindrical or oblong oval, 2-4 × 1  $\mu$ . Odour strong, not unpleasant.

*Habitat* : usually in decaying debris.

*Distribution* : mainly Java and Ceylon; possibly Brazil and South Africa.

*Specimens examined* : Brenton, Knysna, March 1921, A. V. Duthie 291, 31461 (identified by C. G. Lloyd); Belvidere, Knysna, Duthie, 31504.

*Specimens not seen* : Brandfort, Schonken (Duthie 295).

Duthie 291 is probably not *M. bambusinus*, but it is impossible to be sure of the characters since the whole spore-bearing part is lacking. The wall cells are continuous on the outside instead of perforate, which suggests *M. simplex* or possibly *M. Curtisi*. The second specimen, 31504, may possibly be *M. bambusinus*, since the wall cells are perforate on the outside and the spore-bearing part (very shrunken) appears to be thicker than the stipe and differentiated from it. In this case too, the specimen is in fragments and it is impossible to make out anything from the scraps of material. The species is only included in case it does occur in South Africa, which seems doubtful.

2. **ITAJAHYA** Alfr. Möller.

Brasilische Pilzblumen in Botan. Mittheil. a.d. Tropen von A. F. W. Schimper, Heft VII, 1895, p. 79.

*Alboffarella* Spegazzini in Anales del Museo nacional de Buenos Aires, 6, 1899 : 183.

*Type Species* : *Itajahya galericulata* Möller.

This genus resembles *Phallus* in general appearance, but differs in the structure of the pileus which is furnished with lamellate plates, on and between the branches of which the spore mass is borne.

*Itajahya galericulata* is the only well-established species known. Fischer (Nat. Pflanzenfam. 1933 : 102) suggests that *Phallus roseus* Delile may possibly be the same plant.

1. ***Itajahya galericulata* Möller.** [Plate XI; XII; XIII; XIV; XV; XVI.]

Brasilische Pilzblumen (1895) 79, tab. 5.

Ed. Fischer, Nat. Pflanzenfam. (1933) 101; Sacc. Syll. Fung. 11 (1895) 153; Long & Stouffer, Gertero. IX in Mycologia 35 (1943) 620.

? *Alboffarella argentina* Speg., Anales del Museo nacional da Buenos Aires 6 (1899) 183.

*Peridium* 4-8 cm. diam., subglobose, oval or obovate, compressed by mutual pressure when caespitose, white, splitting into several irregular lobes at the apex; attached by a strong, white mycelial cord. *Receptacle* 8-16  $\times$  1.5-4.0 cm., white, cylindrical, tapering at both ends or only towards the base, straight or curved, spongy, hollow, taut, brittle, cellular, wall 3-4-layered, cells finally perforate externally, depressed and usually continuous internally; outer surface originally covered by a thin, white, floccose mycelial layer, which disappears with development, exposing the open cells. Apex at first covered by a semi-transparent membrane, finally perforate or not. *Pileus* 2-4 cm. high, 2-6 cm. broad, campanulate-cylindrical, white, sub-membranous, upper edge attached to the underside of a smooth, white, solid, centrally-depressed cap with irregular margin formed by the recurved expansion of the wall at the apex of the stem; externally shallowly reticulated, the walls of the reticulations giving rise to dichotomously branched, pseudoparenchymatous, white, lamellate expansions which terminate in minute cauliflower-like processes on and between which the spore mass is born. These white, branched tips permeate the dark spore mass and are apparent on the outer surface, giving the latter a mottled appearance. A second white cap (calyptra) —possibly the remains of a volva— may be present on top of the stem cap. (Plate XV fig. 2.). *Spore mass* at first dark grey, finally greenish black, mucilaginous. *Spores* hyaline, smooth, broadly elliptic, about  $4 \times 2 \mu$  diam. *Smell* strong, foetid.

*Habitat*: single, in groups or caespitose, in gardens, under hedges and in open clayey ground, occurring in summer during wet spells.

*Distribution*: South and North America; South Africa; possibly Egypt and Palestine

*Specimens examined*: Pretoria, Jan. 1915, *E. M. Dodge*, 18072; Pretoria, *A. M. Bottomley*, April 1920, 13069, Jan. 1920, 14238, Feb. 1943, 33771, Feb. 1944, 34919; Pretoria, *P. H. B. Talbot*, March 1945, 34147.

As indicated above, this interesting but little known plant was found in South Africa as early as 1915 but was recorded as *Phallus impudicus*; it was only a few years ago, when going through the collections, that its true identity was discovered. It is distinguished from the Phallaceae by the structure of the pileus which gives rise to a number of lamellate plates, the branched tips of which traverse the gleba and give the pileus a mottled appearance.

The South African plant seems to agree more with the Brazilian form than with the North American (Long & Stouffer, *l.c.*) in that no membranous veil has so far been seen and a volva cap is not consistently present.

### 3. PHALLUS Linnaeus ex Persoon.

*Synopsis Methodica Fungorum* (1801) 242.

*emend.* Fries, *Summa Veget. Scandinaviae* (1849) 434.

*Hymenophallus* Nees, *Syst. Pilze und Schwämme* (1817) 251.

*Phallus* § *Ithypallus* Fr., *Syst. Myc.* 2 (1822) 283.

*Phallus* § *Leiophallus* Fr., *l.c.*, p. 294.

*Dictyophallus* Corda, *Anl. Stud. Mycol.* (1842) 190.

*Kirchbaumia* Schulzer, *Verh. zool.-bot. Gesellsch.*, Wien, 16 (1866) 798.

*Omphalophallus* Kalchbr., *Flora* 46 (1883) 95.

*Ithypallus* (Fr.) Ed. Fisch., *Jahrb. bot. Gart. Berlin*, 4 (1886) 41.

*Cryptophrallus* Peck, *Bull. Torrey Bot. Club*, 24 (1897) 147.

*Echinophallus* P. Henn., *Engl. bot. Jahrb.* 25 (1898) 505, *pro parte*.

*Type Species*: *Phallus impudicus* L. ex Pers.

Peridium globose, oval or ovate, splitting irregularly at the apex into several lobes. Receptacle simple, hollow, cellular, cylindrical or fusiform, bearing at its apex a campanulate pileus which may be smooth, rugulose or reticulate. Spore-bearing mass mucilaginous, olive-green, spread over the outside of the pileus. Indusium absent, but an evanescent veil may be present between the pileus and the stem and at the base of the stalk. Spores cylindrical, tinted, smooth. Odour usually foetid.

The presence of a pileus, which bears the spore mass, separates this genus from *Mutinus*, in which the spore mass is borne on the receptacle itself.

*Habitat* : on the ground, single, caespitose or in groups.

*Distribution* : Africa ; North and South America ; Australia ; Ceylon ; India ; East and West Indies ; Japan ; Tasmania.

Of the 26 species recorded for this genus, Cunningham considers that only about 7 are good species. These are grouped in two sections according to the external appearance of the pileus :—

1. Reticulati : Pileus with raised reticulations.  
(*P. costatus*, *P. impudicus*, *P. tenuis*, *P. favosus*.)
2. Rugulosi : Pileus smooth or finely rugulose.  
(*P. glutinolens*, *P. Ravenelii*, *P. rubicundus*.)

Of the above species, one only occurs with certainty in South Africa, viz. *Phallus rubicundus*. *P. impudicus* may or may not occur.

**1. *Phallus impudicus* Linn. ex Pers.** [Plate XVII.]

Commentarius Dr. Jacobi Schaefferi fung. Palat. et Bav. (1800) 80.

Hollós, Gastero. Ungar. (1904) 27 ; Lloyd, Myc. Writ. 2 (1907) ; Myc. Notes p. 327 ; Coker & Couch, Gastero. (1928) 12 ; Ed. Fischer, Nat. Pflanzenfam. (1933) 103 ; Sacc. Syll. Fung. 7 (1888) 8.

*Ithyphallus impudicus* (Linn.) Ed. Fischer, Versuch. syst. Phall. (1886) 43.

*Phallus Hollandicus* vel *Batavicus* Lugd., Hist. 1398 (1586).

*P. (impudicus) volvatus* Linn., Spec. plant. 2 (1648).

*Fungus Phalloides* Bauhin, Hist. Plant. (1651) 843.

*Boletus phalloides* Tournef., Inst. rei herb. I (1719) 562.

*Phallus vulgaris* Michelius, Nova Plant. gen. (1729) 201.

*P. volvatus* Rothm., Vetensk. Acad. Handling (1742) 201.

*Phalloidastrum Bononiense alpinum* Bassii Battarra, Fung. Armin. agri. hist. Ed. II (1759) 75.

*Phallus roseus* Delile, Descript. de l'Egypte Hist. nat. 2 (1813) 300.

*Hymenophallus Hadriani* Nees, Syst. Pilze u. Schwämme (1817).

*Phallus iosmos* Berk., in Sir. J. E. Smith Eng. Flora, Crypt. 5 (1836) 227.

*Phallus foetidus* Sowerby, Engl. Fungi, tab. 329.

*P. imperialis* Schulzer in Kalchbr. Icon. Selecti Hym. Hung. (1877) 63.

Peridium up to 5 cm. diam., globose or egg-shaped, white, sometimes pink or lilac, splitting apically into 2-3 lobes, attached by a stout, white, sometimes pale yellow or pinkish, mycelial cord. Receptacle 5-25 cm. high, typically white, sometimes pale yellow or pink, cylindrical, tapering at the base, cellular, perforated or not at the apex. A rudimentary

veil may be present between the receptacle and the pileus and at the base of the receptacle inside the volva. *Pileus* 4·5-5 cm. long, campanulate, adnate to the receptacle and apically attached to a broad white expansion of the stem apex, externally deeply reticulated with large chambers, reticulations up to 5 mm. deep; internally and at the apex, smooth, greyish-white, grey or brownish, covered by the dark green, mucilaginous spore mass. *Spores* cylindrical, rounded at the ends or elliptic, occasionally pear-shaped,  $2\cdot5-5\cdot5 \times 1\cdot3-2\cdot5 \mu$ , smooth, tinted yellowish.

No specimens of *P. impudicus* have been seen by me and judging from its known geographical distribution, it seems a bit doubtful if the species occurs in South Africa. The above description has been adapted from that of Hollós (l.c.), Lloyd (l.c.) and Coker and Couch (l.c.) to cover all forms.

*Habitat*: on ground in woods, sandy places and on dead wood.

*Distribution*: Europe; Asia; North America, where the pink form known as *P. imperialis* occurs; South America; Java; Ceylon; Japan; ? South Africa.

*South African Records*: Salisbury, S. Rhodesia, Jan. 1925, C. H. Green (Eyles 4140, v. d. Byl 2345); Feb. 1928, J. C. Hopkins (S. Rh. 377, v. d. Byl 2500); Stellenbosch, May 1926, P. van der Byl 2333.

These specimens were examined by me at Stellenbosch and considered to be probably *P. rubicundus*, not *P. impudicus*.

2. **Phallus rubicundus** (Bosc.) Fries. [Plate XVIII.]

Systema Mycologicum 2 (1822) 284.

*Satyrus rubicundus* Bosc., Mag. Ges. nat. Freunde 5 (1811) 86.

*Phallus canariensis* Mont., Phyto. Canariensis (1840) 84.

*P. aurantiacus* Mont., Ann. Sci. Nat. Ser. II, 16 (1841) 277.

*P. novae-hollandiae* Corda, Icon. Fung. 6 (1854) 19.

*P. vitellinus* F. v. Muell., Frag. Phyto. Aus., 7 (1868) 122.

*P. truncatus* Berk., Intell. Obs. 12 (1869) 18.

*P. aurantiacus* var. *discolor* Kalchbr. ex Cooke, Grev. 9 (1880) 2.

*Cynophallus Cayleyi* Berk. ex F. v. Muell., Frag. Phyto 11 (1880) 119.

*Omphalophallus Muellerianus* Kalchbr., Flora 46 (1883) 95.

*Phallus libidinosus* Cayley ex Cooke, Grev. 11 (1882) 58.

*Omphalophallus retusus* Kalchbr., Ungar. Akad. Wiss. 13 (1884) 6.

*Ithyphallus retusus* (Kalchbr.) Ed. Fisch., Jahrb. bot. Gart. Mus. Berlin, 4 (1886) 49.

*I. rubicundus* (Bosc.) Ed. Fisch., l.c., p. 50.

*I. aurantiacus* (Mont.) Ed. Fisch., l.c., p. 51.

*I. rugulosus* Ed. Fisch., Ann. Jard. Bot. Buitenzorg 6 (1887) 35.

*I. balansiae* Pat., Journ. de Bot. (1890) 55.

*Ithyphallus Muellerianus* (Kalchbr.) Ed. Fisch., Denkschr. Schw. nat. Gesellsch., 33 (1893) 34.

*Phallus celebicus* P. Henn., Monsunia 1 (1900) 21.

*Ithyphallus celebicus* (P. Henn.) Ed. Fisch., Denkschr. Schweiz. nat. Gesellsch., 36 (1900) 53.

*Phallus sanguineus* P. Henn., Engl. bot. Jarhb. 30 (1901) 57.  
*Ithyphallus coraloides* Cobb. Agr. Exp. Sta. Hawaii, Bull. 5 (1906) 208.  
*Phallus discolor* (Kalchbr.) Lloyd, Myc. Writ. 2, Phall. Aus. (1907) 10.  
*P. gracilis* (Fisch.) Lloyd, Myc. Writ. 3, Syn. Phall. (1909) 14.  
*Ithyphallus discolor* (Kalchbr.) Sacc. et Trav., Sacc. Syll. Fung. 19 (1910) 987.  
*I. atrominiatus* Bailey, Comp. Cat. Queensland Plants (1910) 746.  
*I. operculatus* Bailey, l.c.  
*Kupsura sphaerocephala* Lloyd, Myc. Writ. 7 (1924) 1303; Verwoerd, S. Afric. Journ. Sci. 25 (1928) 225.

*Peridium* 1.5-3 × 1-1.5 cm., white, globose, then oval or ovate, splitting irregularly at apex into several lobes, attached by a white, branched, cord-like mycelium. *Receptacle* 6-15 cm. × 0.8-1.5 cm., golden yellow, buff, salmon-orange, apricot orange (Light Salmon Orange, Apricot Orange) usually paler towards base, cylindrical or tapering towards base and very slightly towards apex; slightly rugose, hollow, cellular, the wall composed of one to several layers of cells, the majority of the latter opening on the outside, but some towards the inside, perforate or depressed in centre of apex. *Pileus* 1.6-2.8 × 0.9-1.3 cm., thimble-shaped or conical, closely adnate to the receptacle; externally finely to coarsely rugulose, sometimes resembling irregular longitudinal ribs; paler in colour than receptacle, covered by brownish-olivaceous mucilaginous spore mass, attached to apex of stipe by a narrow, white, smooth disc; lower margin even to irregular; the apex often bears the remnants of the volva in the form of a white membranous cap over the disc. *Spores* 4-5 × 2-3  $\mu$ , broadly oval, smooth, tinted. *Odour* strong, very foetid.

*Habitat*: singly or in groups on the ground, chiefly in grassy places, also on cinder embankments.

*Distribution*: Africa; North America; Australia; Hawaii; East Indies; West Indies; India; Tasmania.

*Specimens examined*: Pretoria, *A. M. Bottomley*, Jan. 1920, 12516, det. Ed. Fischer; Jan. 1921, 14237; April 1925, 20369; Feb. 1920, 12809; Feb. 1928, on cinder embankment, 23156; Pretoria, *D. Fouche*, 14643; Feb. 1923, *S. Kraan*, 17001; Feb. 1915, *I. B. Pole Evans*, 9041, 18079; Wonderboom, Pretoria, March 1917, *H. A. V. King*, 10047; Meyerton, Tvl., *Vorster*, 20373; Rustenburg, Feb. 1934, *E. du Toit*, 27363; in mealie lands, Maritzburg, Feb. 1918, *T. R. Sim*, 11322; Johannesburg, Jan. 1918, *J. Burt Davy*, 11011; Brenton, Knysna, *A. V. Duthie* 216, (E.L.S. 56, 413 as *P. rugulosus* Fisch.; Lloyd Myc. Coll. 57821) 31404; Orange Free State, *Miss Olivier*, Jan. 1937 (E.L.S. 490) 34495; see also sub *P. impudicus*.

*Specimens not seen*: Without locality, *Medley Wood* 699, Kew and Berlin (det. Ed. Fischer as *P. aurantiacus* f. *gracilis*, Untersuch. 1893 : 37); Knysna, *Duthie* 208, as *P. gracilis* Fisch. (Lloyd Myc. Coll. 50084); Brandfort, O.F.S., *Schonken* (Duthie 299); without locality, *Duthie* (Lloyd Myc. Coll. 24893); Sydenham, Natal, *Holwell*, Kew; ? Boschberg, nr. Somerset East, *Tuck & MacOwan* (MacOwan 1225, 1286 as *P. campanulatus*); Knysna, 1924, *A. V. Duthie*—egg stage named by Lloyd *Kupsura sphaerocephala* (Myc. Writ. 1924 : 1303); later specimens of the latter from the same place were developed by Verwoerd (S. Afric. Journ. Sci. 25, 1928) and determined as *Phallus rugulosus*; Rondebosch, C.P., Dec. 1939, *Mrs. Crawford* (E.L.S. 555, 556).

*T. R. Sim* 11322.—Dr. Sim supplies the following information in connection with this specimen:—"Known to the natives as 'i-sona' and said by them to destroy the mealie plant wherever it grows." There is no confirmation of this. Cobb recorded this species as parasitising sugar cane in Hawaii.

*A. V. Duthie* 216.—Dr. Duthie included a coloured sketch with this specimen illustrating the development of the plant from the spherical egg stage to the expanded plant. The receptacle is  $9 \times 1$  cm., the stalk and apical disc yellow, and the eggs, volva and rooting mycelial cord pale rose pink. Fresh specimens are necessary to confirm the identification of this plant.

This species is recognised by its usually finely rugulose pileus and its buff, orange or red stalk. It is the commonest species in the summer rainfall areas, occurring plentifully in wet seasons from January to April. It collapses after a few hours. The plant shows considerable variation in size, shape and colour. There seem to be two distinct forms—a tall, slender plant with acuminate stalk and slightly protruding disc and a shorter, more robust form with thimble-shaped pileus and flattened apex.

*Excluded species.*

**Phallus campanulatus** Berk.

Ann. & Mag. Nat. Hist. 9 (1842) 446; Grev. 10 (1880) 106.

*Ithyphallus campanulatus* (Berk.) Schlecht. in Sacc. Syll. Fung. 7 (1888) 11.

*South African Record* : Boschberg, nr. Somerset East, *Tuck & Macowan* (MacOwan 1225, 1286). Fischer in Sacc. Syll. Fung. l.c., queries whether these specimens are *P. campanulatus* and suggests that they resemble *P. rugulosus*, in which case they should be included in *P. rubicundus*. Berkeley l.c., makes the observation that these specimens differ from *P. impudicus*, not yet found in Africa, in the globose instead of oval egg and the broadly campanulate pileus, which is rugose rather than reticulated. He does not mention the colour of the stipe, which in *P. campanulatus* is described as dirty white.

**4. DICTYOPHORA** Desvaux.

*Journal de Botanique*, 2 (1809) 88.

*Hymenophallus* Nees, Syst. Pilze u. Schwämme (1817) 251.

*Phallus* § *Hymenophallus* Fr., Syst. Myc. 2 (1822) 282.

*Sophronia* Pers., in Gaud. Voyage aut. Monde (1836) 178.

*Retigerus* Raddi, Mem. Soc. Ital. Moden., 20 (1829) 46.

*Dictyophora* § *Clautriavia* Fat., Bull. Soc. Myc. France 14 (1898) 190.

*Clautriavia* (Pat.) Lloyd, Myc. Writ. 3, Syn. Phall. (1909) 24.

Type Species: *Dictyophora indusiata* (Vent. ex Pers.) Desv.

This genus is the same as *Phallus*, except that it has an indusium—a pseudoparenchymatous, netlike structure, which is attached under the pileus to the apex of the stem and hangs down around the latter for a considerable distance below the pileus. *Dictyophora indusiata* (Vent. ex Pers.) Desv. is the only species so far known in South Africa.

**1. Dictyophora indusiata** (Ventenat ex Persoon) Desvaux. [Plate XIX.]

*Journal de Botanique* 2 (1809) 192.

*Phallus indusiatus* Vent. ex Pers., Syn. Meth. Fung. (1801) 244; Lloyd, Myc. Writ. 2 (1907) 332.

*Dictyophora phalloidea* Desv., Journ. de Bot. 2 (1809) 92.

*D. campanulata* Nees, in Lév., Mem. Soc. Linn. Paris 5 (1827) 499.

*Phallus* § *Hymenophallus subiculatus* Mont., Ann. Sci. Nat. Ser. II, 18 (1842) 244.

*Dictyophora bicampanulata* Mont., Ann. Sci. Nat. Ser. III, 10 (1848) 120.

*D. radicata* Mont., Ann. Sci. Nat., Ser. III, 3 (1855) 137.  
*Phallus tunicatus* Schlecht., Linnaea 31 (1861) 123; Welwitsch & Currey, Trans. Linn. Soc. 26 (1870) 286.  
*P. brasiliensis* Schlecht., l.c. p. 124.  
*P. tahitiensis* Schlecht., l.c., p. 126.  
*Dictyophora nana* Berk. ex Cooke, Grev. 11 (1882) 59.  
*Phallus collaris* Cragin, Bull. Washburn Coll., 1 (1885) 33.  
*P. diplopora* Mont. ex Ed. Fisch., Denkschr. Schweiz nat. Gesell. 32 (1890) 81.  
*Dictyophora Farlowii* Ed. Fisch., l.c. p. 83.  
*D. callichroa* Moell., Braz. Pilz. (1899) 129.  
*D. lilloi* Speg., Anal. Mus. Nac. Buenos Aires 16 (1906) 30.  
*Phallus callichrous* (Moell.) Lloyd, Myc. Writ. 2, Phall. Aus. (1907) 6.  
*P. rochesterensis* Lloyd, Myc. Writ. 3, Syn. Phall. (1909) 20.  
*P. Moelleri* Lloyd, l.c.  
*Dictyophora Baileyi* Ulbr., Bericht. Deutsch. Bot. Gesell. 50 (1932) 295.

*Peridium* up to  $5 \times 4.5$  cm. diam., globose or obovate, white, attached by a stout white, single or branched cordlike mycelium. *Receptacle* up to  $14 \times 2$  cm., white, hollow cellular, wall of several layers, cylindrical, round or elliptic, apex perforate or not. *Pileus* up to 5 cm. high, 3.2 cm. at widest part, campanulate, usually deeply rugulose-reticulate, with large, equal or elongated chambers, in the base of which are secondary shallow reticulations, latter up to 3 mm. deep, with even or incised edges; attached apically to a white, caplike expansion of the apex of the stem. *Indusium* white, closely convoluted and rugulose when immature, developing into an open network structure, in which the meshes are about 1.5-3 mm. diam., subglobose to irregularly polygonal and the walls of the meshes elliptic, the long axis at right angles to the stem; attached to the apex of the stem and hanging down between the stem and the pileus, fairly straight or flared at the lower margin, up to just above the volva. *Spores* tinted, smooth, broadly elliptic, about  $3.5-4.5 \times 2.5 \mu$ .

*Habitat*: solitary or in clusters, in soil and decaying leaves, after rain.

*Distribution*: Africa; North and South America; Asia; Australia; Ceylon; India; East and West Indies.

*Specimens examined*: Inanda, Natal, *Haygarth* (Medley Wood 667; Herb. Kew as *Phallus indusiatus*) 11050; Pinetown, Natal, *Medley Wood* 669 as *P. indusiatus*, 11051; Mbahane, Swaziland, *L. Hendricks*, 15047; Richmond, Natal, May 1925, *Miss Vivyan*, 20413; Newlands, Cape, June 1929, *K. Lansdell*, 24380; July 1929, *E. L. Stephens* 55 as *D. duplicatus* (Bosc.) Ed. Fisch., 24379; Hopevale, Donnybrook, Natal, Jan. 1935, *K. Morgan*, 34921; Natal, *D. Weintraub*, 34920; Pietermaritzburg, Natal, Nov. 1936, *R. Fuller* (Rump 457); Quden Forest, Zululand, Feb. 1945, *P. Talbot*, 34909; (Kirstenbosch, Cape, July 1929, *R. Marloth* 14045 as *D. phalloidea*, 26588, is a *Clathrus*); Cape Peninsula, *E. L. Stephens*, 426, 555, 556.

*Specimens not seen*: Inanda, Natal, *Medley Wood* ? 667 at Kew; Angola, Welwitsch as *P. phalloidea* Desv.; Hogsback, Alice Distr., Cape, Jan. 1939, *E. L. Stephens* 426.

The South African plant differs from the type figured by Alf. Moeller for Brazil (Brasilische Pilzblumen, 1895; tab. 1, 4, 8) as *D. phalloidea* and reproduced by Ed. Fischer (Nat. Pflanzenfam., 1933: 106) as *D. indusiata* (Pers.) Ed. Fisch. by C. G. Lloyd (Myc. Writ. 3, Syn. Phall., 1909: 19) as *D. Moelleri* and by R. Marloth (Fl. South Africa 1, 1913: 30) as *D. phalloidea* in the following characters:—The net, even when first expanded, is never so campanulate and rigid or proportionally so long, the walls of the meshes are elliptical and deeper in the horizontal axis and the meshes are more angular and not so large.

## CLATHRACEAE Ed. Fischer.

Natürlichen Pflanzenfamilien 1\*\* 1 (1900) 280.

Peridium of three layers, subglobose, oval or obovate, splitting irregularly at the apex to allow for the development of the receptacle, at the base of which it remains behind as a volva collapsed against the stem. Receptacle stipitate or sessile, cellular or tubular, of a turgid, spongy, brittle texture, consisting either of a number of simple columns united at the apices but free at the base, or of a simple, hollow, cylindrical stem from the apex of which arise either a number of free connivent, or apically united armlike processes, or a simple or processed clathrate dome, or consisting entirely of a number of arms fused at intervals to form a hollow, latticed dome. Spore mass mucilaginous, olivaceous, foetid, borne on the armlike structures of the receptacle, whether free or formed into a clathrate sphere. Spores smooth, hyaline, bluntly cylindrical. Basidia 4-8-spored.

## Key to the Genera (sec. Cunningham).

A.—Receptacle composed of a number of columns, fused at the apices but basally free.

1. Spore mass borne on the inner surface of smooth or transversely rugose columns..... 1. **Linderiella.**  
(*Blumenavia*).
2. Spore mass borne on the inner surface of lateral expansions of the columns.....
3. Spore mass borne on a pulvinate structure pendant from the inner side of the fused apices of the columns..... 2. **Anthurus.**  
(*Laternea*).

B.—Receptacle composed of a hollow, cylindrical stem, the apex of which gives rise to a number of armlike structures.

1. Arms originally fused at the apices. Spore mass borne on the inner surface of rugulose arms..... 1. **Anthurus.**
2. Arms connivent and usually organically free at the apex. Spore mass surrounding rugulose arms except for a central longitudinal furrow on the outer surface.....
3. Arms laterally attached to a horizontal, discoid expansion of the apex of the stem. Spore mass borne on the upper side of the arms and disc..... 2. **Lysurus.**  
3. **Aseroe.**

C.—Arms united to form a hollow, spherical, latticed type of stipitate or non-stipitate receptacle.

1. Arms forming a simple, hollow, latticed sphere.
  - a. Spore mass borne on the inner surfaces of the arms..... 5. **Clathrus.**
  - b. Spore mass borne on the inside of the fusion point of the arms..... 6. **Clathrella.**
2. Arms forming a spherical, latticed structure on the apex of a well-developed, cylindrical, hollow stem.
  - a. Latticed dome simple. Spore mass borne on the sides of the rugulose arms.....
  - b. Latticed dome furnished with radiating armlike processes. Spore mass borne on the sides of the arms and on the processes.... 7. **Kalchbrennera.**  
(*Simblum*).
3. Arms forming a hollow, latticed sphere, supported on several columns basally attached to a short hollow, flaring, tubular stem..... 6. **Clathrella.**  
(*Colus*).

Fischer (Gastero. in Nat. Pflanzenfam., 1933 : 83) includes five additional genera in the Clathraceae—*Colonnia*, *Ileodictyon*, *Pseudocolus*, *Mycopharus*, *Claustula*. These, however, Cunningham rejects on the grounds either that they are not sufficiently well described or that they are not sufficiently well defined to rank as separate genera. He rejects *Colonnia* for the first reason, and substitutes *Linderiella*; *Ileodictyon* and *Clathrella* he considers synonyms of *Clathrus*, *Pseudocolus* a synonym of *Anthurus* and *Mycopharus* a synonym of *Lysurus*. *Claustula* he transfers to the *Phallaceae*.

Of the genera included in the key and so far not found in South Africa, *Blumenavia* is limited to Brazil; *Laternea* is confined to the West Indies; *Simblum* is found in North and South America and the East and West Indies; *Colus* is found along the Mediterranean and in Australia.

*Kalchbrennera*, *Anthurus*, *Lysurus*, *Clathrus* and *Clathrella* definitely occur in South Africa; *Aseroe* and *Colus* have both been reported from this country, but their occurrence seems doubtful.

### 1. LINDERIELLA G. H. Cunningham.

New Zealand Journal of Science and Technology 23 (1942) 171 B.

*Linderia* G. H. Cunn., Proc. Linn. Soc. N.S.W. 56 (1931) 192.

*Colonnaria* Raf., N.Y. Med. Rep. Hax. 5 (1808) 355; Fisch. Gastero. in Nat.

Pflanzenfam. 7a (1933) 84.

Type species : *Linderiella columnata* (Bosc.) G. H. Cunn.

Peridium subglobose, white or greyish. Receptacle of simple columns, organically united at the apex, but free and tapering at the base. Columns chambered, pseudoparenchymatous, smooth or transversely wrinkled, not winged, bearing on the inner surface the mucilaginous, olivaceous spore mass. Spores elliptical, smooth. Basidia 4-8-spored.

Cunningham originally erected the genus *Linderia* to include species answering to the above description, but later renamed it *Linderiella*, on account of the similarity of the name to *Lindera*, a flowering plant. Fischer resuscitated the genus *Colonnaria* Raf. for such species, but Cunningham rejected this name on the grounds that Rafinesque did not describe or illustrate his genus.

***Linderiella columnata* (Bosc.) G. H. Cunningham.** [Plate XX, fig. 1, 2.]

New Zealand Journal of Science and Technology 23 (1942) 171 B.

*Clathrus columnatus* Bosc., Mag. Gesell. Nat. Freunde 5 (1811) 85.

*C. colonarius* Leman, Dict. Sci. Nat. 9 (1817) 360.

*Laternea columnata* Nees & Henry, Syst. der Pilze 2 (1858) 96.

*Laternea angolensis* Welw. & Curr., Trans. Linn. Soc. London 26 (1870) 286.

*Clathrus angolensis* (Welw. & Curr.) Fisch., Versuch. Phall. (1886) 70.

*Clathrus cancellatus* f. *columnatus* Ed. Fisch., Denkschr. Schw. nat. Gesell. 32 (1890) 56.

*C. trilobatus* Cobb, Rept. Exp. Sta. Hawaii, Bull. 5 (1906) 209.

*Linderia columnata* (Bosc.) G. H. Cunn., Proc. Linn. Soc. N.S.W., 56 (1931) 193.

*Colonnaria columnata* (Bosc.) Ed. Fisch., Nat. Pflanzenfam. 7a (1933) 84.

Peridium 3-6.5 cm. diam., subglobose, white or greyish flecked with brown. Receptacle 12 cm. high, of 3-5, commonly 3-4, columnar arms, basally free, acuminate pointed, organically united at the apex, arched slightly outwards, chambered, transversely rugulose or papillate on the inner side, longitudinally striate on the outside, shading from pale orange at the base to scarlet at the apex. Spore mass olivaceous, mucilaginous, borne on the inner surfaces of the upper portions of the arms. Spores bluntly cylindrical, tinted, smooth. 4-6 x 1.5-2  $\mu$ . Smell foetid, said by Welwitch and Curry, l.c., to resemble the odour of fermenting wine. (Description ex Cunningham l.c. and Welwitsch & Currey, l.c. sub *Laternea angolensis*.)

*Habitat* : in humus.

*Distribution* : North and South America; Africa; Hawaii; New Zealand; West Indies.

*African Record* : on humus-covered soil, at Catete, Pungo Andonga, Angola, Dec. 1856, *Welwitsch* 120.

According to Cunningham, the plant shows variations in colour, number and shape of the columnar arms. It differs from *Clathrus*, with which it has been confused, in that the arms are free, not united at the base. The Angola plant is not a *Laternea* as described by Welwitsch and Currey (l.c.) since the spore mass is borne, not on a projection from the anastomosed apex of the inner walls of the arms, as in that genus, but on the walls themselves. Following Cunningham, it has been referred to *Linderiella columnata* (Bosc.) Cunn. It differs from the New Zealand plant mainly in colour—being white instead of some shade of yellow or red—and in smell.

## 2. ANTHRUS Kalchbrenner and MacOwan.

ex Kalchbrenner and Cooke, *Grevillea* 9 (1880) 2.

emended G. H. Cunningham, *Proc. Linn. Soc. N. S. Wales* 56 (1931) 185.

*Pseudocolus* Lloyd, *Myc. Writ.* 2, *Myc. Notes* 28 (1907) 356.

Type species: *Anthurus Archeri* (Berk.) Ed. Fischer.

Peridium globose, oval or ovate, splitting irregularly at the apex, strongly rooting. Receptacle a short, hollow, cellular, cylindrical or flaring stem-like structure, dividing at the upper margin into a number (3-8) of simple, sub-cylindrical, cellular arm-like processes, which are originally organically united at the tips, but which usually break free on expansion. Spore mass dark olive green, mucilaginous, foetid, borne on the inner surfaces of the arms. Spores bluntly elliptical, smooth, hyaline or tinted.

### **Anthurus Archeri** (Berkeley) Ed. Fischer. [Plate XXI, fig. 1, 2.]

*Jahrbuch der Koeniglichen botanischen Gartens und botanischen Museums, Berlin* 4 (1886) 81; emend. G. H. Cunn., *Proc. Linn. Soc. N. S. Wales*, 56 (1931) 186.

*Lysurus Archeri* Berk., *Fl. Tasmania* 2 (1860) 264.

*L. pentactinus* Berk., l.c., Tab. 184.

*Anthurus Muellerianus* Kalchbr., ex Kalchbrenner & Cooke, *Grev.* 9 (1880) 2.

*A. Muellerianus* f. *aseroeformis* Ed. Fisch., *Denkschr. Schweiz. nat. Gesell.* 32 (1890) 68.

*A. sepioides* McAlp., *Victorian Nat.*, 20 (1904) 42, *nomen nudum*.

*A. aseroeformis* (Ed. Fisch.) McAlp., in Lloyd, *Myc. Writ.* 2, *Myc. Notes* 31 (1908) 408.

*Pseudocolus Archeri* (Berk.) Lloyd, *Myc. Writ.* 4, *Letter* 47 (1913) 14.

*Anthurus MacOwani* Marloth, *Flora of South Africa* 1 (1913) 22, Pl. 3.

*Pseudocolus mauritianus* Lloyd, *Myc. Writ.* 5, *Myc. Notes* 49 (1917) 689.

*Anthurus surinamensis* Ed. Fischer., *Ann. Myc.* 25 (1927) 471.

Peridium 1.7-5 cm. high, 1.7-3.2 cm. wide, globose, oval or ovate, white, splitting irregularly at the apex, attached by means of a stout, white, much branched mycelial cord, branches sometimes firmly attached to tree roots. Peridia usually single, but two to three closely adpressed eggs may be attached to one rooting system. Receptacle composed of a short stalk-like base, flared at the margin but attenuated towards the point of attachment to the volva, and dividing at the apical margin into 4-6, long, sub-cylindrical, arm-like processes, which are originally connivent and organically united at the tips and on the inner side of which the spore mass is borne. Stem 1-5 cm. long, about 2.5 cm. wide at upper margin, hollow, brittle, spongy, cellular, walls of 1-2 layers of cells which occasionally open towards the outside, but for the most part are closed inside as well as outside, transversely and strongly rugulose, white at the base, reddish above. Arms up to 14 cm. long

and 2 cm. diam. at widest part, lanceolate acuminate, the tips originally anastomosed together, but usually soon separating and becoming flared and recurved; strongly transversely rugulose, rounded on the inside, flattened and centrally channeled on the outside, spongy, brittle, cellular, not hollow—consisting of up to 7 layers of large and small cells, the largest on the inside and the smaller towards the outside; bright red (Nopal Red) on the inside, whitish on the outside, but tinged with red towards tip. Spore mass greenish black, borne on the inner side of the rugulose arms, at first distributed, later concentrated in patches. Spores tinted greenish, smooth, bluntly cylindrical, about  $6-6.8 \times 2 \mu$  (in alcohol).

*Habitat*: in wooded places, often under oak trees, occurring singly, in groups or caespitose, appearing after rain.

*Distribution*: South Africa; Australia; Malay Archipelago; Mauritius; New Zealand; Tasmania.

*Specimens examined*: Stellenbosch, Nov. 1916 and June 1927, *Duthie* 173 (E.L.S. 411) 31381; June 1932, *Duthie* 343 as *Pseudocolus*, 31496; Oranjezicht, Capetown, July 1929, *A. M. Bottomley*, 24371; near oaks and pines, Paagaaiberg, June 1941, *M. de Vos*; Stellenbosch, *P. v. d. Byl* 2332; Kirstenbosch, Aug. 1934, *J. Acocks* (E.L.S. 334); Capetown University grounds, May 1939, *E. L. Stephens* 552; Orangezicht woods, Cape Town, June and July, 1925-1929, *J. U. L. Rennie* and *E. L. Stephens* (E.L.S. 168, 417).

*Specimens not seen*: Somerset West, *C. P. Pillans*; Stellenbosch, *v. d. Byl* 2101.

This is the only species of *Anthurus* known in South Africa. It is fairly common in oak woods in the South Western coastal area, where winter rainfall conditions prevail, but it has not so far been found elsewhere. It often occurs in clusters, which present a beautiful sight, often being mistaken for bright red flowers. Like all phalloids it is very brittle and quickly collapses, which probably accounts for the small number of specimens in Herbaria.

The species is recognised by its brilliant red colour, the long rugose arms, which spread out like the petals of a flower, and the greenish black, slimy spore mass on the inside of the arms. Growing as it does amongst leaves, the arms appear to come straight out of the ground.

Marloth (l.c.) described the plant as a new species, on advice from Lloyd to whom he submitted a coloured illustration. Lloyd (Myc. Writ. 4, Myc. Notes 41, 1916 : 570), however, later admitted that the South African plant looked very much like the Australian, which he said he knew imperfectly at the time and of which he had seen no illustration. There seems little doubt that the two are the same. Uncertainty has probably arisen owing to the fact that in the South African plants the tips of the arms apparently separate at a very early stage of expansion. A study of numerous alcohol specimens, however, shows several cases of joined tips - some united by only a single layer of cells, others by a band of tissue.

### 3. LYSURUS Fries.

*Systema Mycologicum* 2 (1822) 285.

*Aseroephallus* Lepr. et Mont., *Ann. Sci. Nat. Ser. 3, 4* (1845) 360.

*Pharus* Petch, *Ann. Bot. Gard. Peradeniya*, 7 (1919) 59.

*Mycopharus* Petch, *Trans. Brit. Myc. Soc.* 10 (1926) 281.

Type species: *Lysurus Mokusii* (Linn.) Fr.

Peridium subglobose, splitting at the apex into several irregular lobes. Receptacle consisting of a well-developed, hollow, spongy, cellular, cylindrical stem, which bears at its apex a number of rugose, acuminate, erect, usually apically free, armlike processes.

Spore mass mucilaginous, foetid, borne on the rugose tissue of which the whole arm, except for a narrow, longitudinal, central channel on the outer surface, is composed. Spores tinted, smooth, bluntly cylindrical.

The two genera *Anthurus* and *Lysurus* were confused for a long time and to Lloyd is due much of the credit for straightening out some of the differences. In *Lysurus* as seen in South African plants, the stemlike portion of the receptacle is well-developed and cylindrical, the arms are short in proportion, the arm tips are connivent, but nearly always separate, and the spore mass is borne all over the arms except for a narrow, longitudinal, slightly wrinkled channel in the centre of the outer surface. In *Anthurus* on the contrary, the stemlike portion is short and flaring, the arms are proportionately long, the arm tips originally organically united, but later usually free and flaring; the spore mass is confined to the inner side of the arms, where it is concentrated in patches at maturity. A central longitudinal furrow is present on the outside of the arms.

According to Cunningham, only four of the nine described species of *Lysurus* are good species—*L. Mokusii*, reported from Asia, Australia and California and distinguished by its angled and fluted stem and strongly connivent arms; *L. cruciatus*, reported from French Guiana, a very small species with four arms, in which the spore mass is borne between the arms on the top of the stem; *L. Gardneri*, described later and *L. Woodii* confined to South Africa. The latter was, however, considered by Lloyd (Myc. Writ. 5, Myc. Notes 55, 1918 : 792) to be the same plant as *L. borealis*, the American form of *L. Gardneri* and this opinion is upheld by the writer. The number of good species would therefore be three only.

**Lysurus Gardneri** Berkeley. [Plate XXII.]

Hooker's London Journal of Botany 5 (1846) 535.

G. H. Cunn., Gastero. (1944) 105.

*Lysurus texensis* Ellis, Bull. Torrey Bot. Club 7 (1880) 30, nomen nudum.

*Anthurus Woodii* MacOwan in Kalchbr. Phall. novi vel minus cognita (1880) 23.

*Colus Gardneri* (Berk.) Ed. Fisch., Jahrb. Bot. Gart. Mus. Berlin 4 (1886) 77.

*Mutinus sulcatus* Cooke et Massee, ex Cooke, Grev. 17 (1889) 69.

*Lysurus australiensis* Cooke et Massee, ex Cooke, Grev. 18 (1889) 6.

*Anthurus australiense* (Cooke et Massee) Ed. Fisch., Denkschr. Schweiz. nat. Gesell., 33 (1893) 27.

*A. borealis* Burt, Mem. Boston Soc. Nat. Hist. 3 (1894) 504.

*L. borealis* (Burt) P. Henn., Hedwigia 41 (1902) 167.

*L. borealis* var. *Klitzingii* P. Henn., l.c., p. 173.

*L. Woodii* (MacOwan) Lloyd, Myc. Writ. 3, Syn. known Phall. (1909)

*L. tenuis* Bailey, Comp. Cat. Queensland Plants (1910) 745.

*Pharus Gardneri* (Berk.) Petch, Ann. Bot. Gard. Peradeniya 7 (1919) 59.

*Mycopharus Gardneri* (Berk.) Petch, Trans. Brit. Myc. Soc. 10 (1926) 281.

*Lysurus sulcatus* (Cooke et Massee) G. H. Cunn., Proc. Linn. Soc. N. S. Wales 56 (1931) 189.

*Peridium* up to 4 cm. diam., subglobose, white, splitting at apex into several irregular lobes, attached to soil by white mycelial strands. *Receptacle* composed of a well-developed stem, which bears at its apex, where a constriction may or may not be present, 5-7 rather short, erect, or later flaring, arm-like processes on which the spore mass is borne. *Stem* 3-14 cm. long, 0.5-3.8 cm. diam at apex, 0.3-1.5 cm. diam. at base; cylindrical or slightly

to strongly attenuated towards the base, hollow, brittle, cellular, wall 1-3-chambered, cells closed on the inside but usually finally open on the outside, white at the base, whitish or tinged pinkish-yellow, waxy yellow or pinkish orange (Pinkish Buff) in the central part and finally warm buff (between Cinnamon and Mikado Brown) at apex. Arms 5-7 (MacOwan recorded 8-9), acuminate, up to 5 cm. long, usually about 2 cm., 7 mm. diam. at base, arising from the apical margin of the stem and in some cases attached to a semi-transparent membrane, sub-triangular, flattened on the outside and rounded-angular on the inside, transversely deeply rugose all over the arm except for a slightly wrinkled, central, longitudinal channel on the outside, the rugose tissue extending from the base of one arm to the next in hair-pin bend fashion; pinkish orange (in specimens seen by me) orange red, rose red, scarlet or sometimes white, the colour being conspicuous along the spore-free channel; tips connivent, two or very occasionally three, originally organically united, but usually free, erect or becoming flared, held erect at the base by the thick spore mass filling the space between the apex of the stem and the arms. Spore mass fuscous brown, mucilaginous, copious, covering the entire rugose surface of the arm except for the outside channel. Spores bluntly cylindrical, smooth, tinted,  $4-4.5 \times 1.5-2 \mu$ , average size  $4 \times 1.6 \mu$ . Smell foetid, reported by MacOwan to be "ten times worse than *Phallus impudicus*".

*Habitat* : under wattle trees in cattle-manured ground, manured gardens, damp soil, occurring singly or in large clusters.

*Distribution* : South Africa; North America; Australia; Ceylon; England; Germany; India; Java.

*Specimens examined* : Inanda, Natal, 1877/78, *J. Medley Wood* 134, 10376, 22036 (Kew as *Anthurus Woodii* Kalchbr.); Hopevale, Donnybrook, Natal, *K. E. Morgan*, Jan. 1935, 27741, Feb. 1936, 28536, May 1936, 28607; Putfontein, nr. Benoni, Tvl., Feb. 1929, *Miss v. d. Merwe*, 23685; Johannesburg, Jan. 1921, *J. B. Wood*, 14245; de Kuil, Standerton Distr., Tvl., Dec. 1924, *Roos*, 20355; Brenton, Knysna, June 1924, *A. V. Duthie* (E.L.S. 54) 31508, April 1935, *A. V. Duthie* 338 (v. d. Byl 2369 as *Anthurus Woodii*), *A. V. Duthie* 331 (v. d. Byl 2334; Lloyd Myc. Coll. 24890, 24891, 27631); Grahamstown, Aug. 1941, *Miss E. Archibald*, 33215.

*Specimens not seen* : Inanda, Natal, *J. Medley Wood* 149; Ixopo, Natal, *Mrs. J. C. Hackland* as *Lysurus Woodii*; Brenton, Knysna, *Duthie and Mason* (Duthie 341).

This is the only species of *Lysurus* so far found in South Africa. It is recognised by its well-developed, usually pinkish-orange stem, which bears at its apex a number of comparatively short, connivent, armlike, yellow-scarlet processes, around which, except for a narrow, longitudinal central channel on the outer surface, the fuscous brown spore mass is borne. Cunningham does not mention the external channel, which is presumably absent in Australian plants.

The plant is very variable in size, colour and attachment of the arm tips. Cunningham describes the arms, after removal of the spore mass, as orange red; van der Byl (Trans. Roy. Soc. S. Africa 9, 1921 : 191) found them to be white in Natal plants and partly on this character supported his claim for retaining *L. Woodii* as a separate species; MacOwan (l.c.) described them as "magnificent yellow-scarlet like *Clathrus*" and in Natal plants seen by the author they were pinkish orange.

The arm tips in the South African plant are connivent but usually free. In a couple of cases two tips have been found organically united, in one case apically by a thin strip of tissue and in the other laterally, by so broad a layer of tissue that it was impossible to separate them. Variation in the number of arms and in the tip attachment has been responsible for the numerous names this plant has received.

It is considered that v. d. Byl's arguments for retaining *L. Woodii* as a separate species fall away in the light of Cunningham's interpretation of *L. Gardneri*.

The foregoing description was largely made from numerous plants "hatched out" in the laboratory from "eggs" kindly supplied by Miss K. E. Morgan of Hopevale, Donnybrook, Natal.

4. **ASEROE** La Billardiere ex Fries.

Systéma Mycologicum 2 (1822) 285; Labill., Relation du voyage recherche de la Perouse (1800) 145.

*Calathiscus* Mont., Ann. Sci. Nat., Ser. 2, 16 (1841) 278.

Type species : *Aseroe rubra* Labill., ex. Fr.

Peridium globose or obovate, splitting at the apex into a number of irregular lobes. Receptacle of a well-developed, cellular, hollow, cylindrical or flaring stem, which gives rise at the apex to a horizontal, disc-like structure, extending inwards to form a centrally perforated diaphragm over the apex of the stem and outwards to form an expansion from which a number of simple or forked, long, acuminate, rugulose arms radiate. Spore mass mucilaginous, olivaceous, foetid, borne on the upper side of the diaphragm, disc expansion and adjoining arms. Spores hyaline or tinted, smooth, bluntly cylindrical.

Of the nine species of *Aseroe* described, both Fischer and Cunningham recognise only two as valid—*A. arachnoidea*, a white plant with simple arms attached to a very small disc, which occurs in Borneo, Cochin China, Java and Sumatra and *A. rubra*, a red plant with arms attached to a well-developed disc. Fischer (Gastero., Nat. Pflanzénfam., 1933 : 93) further divides the latter species into six varieties.

It is uncertain if this genus is represented in South Africa, but in view of the fact that a collection, identified as *A. rubra* has been recorded from the South Western Cape area, a description of this species (taken from Cunningham) is given.

**Aseroe rubra** La Billardiere ex Fries. [Plate XX, fig. 3.]

Systema Mycologicum 2 (1822) 285.

*Aseroe pentactina* Endl. Icon. Pl. Gen. (1838) 50.

*A. viridis* Berk. et Hook., Lond. Journ. Bot. 3 (1844) 192.

*A. ceylanica* Berk., Lond. Journ. Bot. 5 (1846) 535.

*A. actinobola* Corda, Icon. Fung. 6 (1854) 23.

*A. multiradiata* Zoll., Syst. Verz. (1854) 11.

*A. Hookeri* Berk., Fl. New Zealand 2 (1855) 187.

*A. corrugata* Col., Trans. New Zealand Inst., 16 (1884) 362.

*A. rubra* f. *Muelleriana* Ed. Fisch., Jahrb. Bot. Gard. Mus. Berlin 4 (1886) 88.

*A. lysuroides* Ed. Fisch., l.c., p. 89.

*A. rubra* f. *ceylanica* (Berk.) Ed. Fisch., Denkschr. Schweiz. Nat. Gesell. 32 (1890) 75.

*A. Muelleriana* (Fisch.) Lloyd, Syn. Phall. in Myc. Writ. 3 (1909) 46.

*A. pallida* Lloyd, l.c., p. 47.

*A. poculiforma* Bailey, Comp. Cat. Queensland Plants (1910) 746.

Peridium up to 3 cm. diam., globose or obovate, dingy white or grey, sometimes fuscous. Receptacle consisting of a well-developed stem, up to 6 cm. long, 2 cm. diam., cylindrical or flaring, hollow, cellular, white below, pink above, giving rise abruptly at the apex to a usually broad, horizontal, round, disc-like structure up to 3.5 cm. diam., which extends inwards to form a centrally perforated, rugulose or smooth, white, yellow or red, diaphragm over the apex of the stem and, outwards, to form a rounded expansion from the margin of which armlike processes, with often twisted or curled ends, radiate. Arms up to 3.5 cm.

long, 6 mm. wide at the base, in 5-9 pairs, longitudinally grooved at the base, rugose on both surfaces or almost smooth, bifurcate about 15 mm. from the base or sometimes only near the apices, typically some shade of orange or red, sometimes white. Spore mass mucilaginous, olivaceous, covering the upper side of the diaphragm, disc expansion and adjoining basal portions of the arms. Spores hyaline or tinted, smooth, bluntly cylindrical,  $4.5-5 \times 1.5-2 \mu$ . Smell foetid.

*Habitat* : on ground or rotting wood.

*Distribution* : Australia; Ceylon; England; Malay Archipelago; New Caledonia; New Zealand; Tasmania; ? South Africa.

*South African Records* : only one collection of *Aseroe rubra* has been recorded from South Africa—that in Kew Herbarium collected by the botanist W. T. Saxton at Cape Town. While it is, of course, possible that the plant does occur here, it seems rather doubtful, in view of the fact that no other collection is recorded and that the same phalloids come up regularly year after year in the area in question. The plant may conceivably have been confused with *Anthurus Archeri*, which is also red and which occurs quite commonly in the Cape Town area, especially if the identification was made from a dried specimen.

Lloyd (Synop. Phall. in Myc. Writ. 3, 1909 : 44) mentions a very imperfect, dried specimen of *Aseroe* from Africa in Berlin which was, however, in too poor a condition for him to attempt to identify.

#### Clathrus and Clathrella.

*Clathrus* and *Clathrella* are the least well-known genera of the phalloids in South Africa, occurrence beyond the coastal belt, a thousand miles from Pretoria, being of a very sporadic nature and usually limited to single plants. Specimens have occasionally been sent to Fischer and Lloyd for identification, but in no case has it been possible to name them exactly. In spite of the lack of definite specific names, however, all forms recorded for South Africa have been included for the sake of future workers on this group.

According to Fischer, *Clathrella* differs from *Clathrus* in the following characters:—Different apex and base, less massive structure, at least partly tubular arms, the presence on the inside, in typical plants, of a projecting chamber at the junctions of the arms, the uniting, basally, of the arms into a short, stemlike structure and the restriction of the spore mass to the axils of the arms, which he contends indicates an anatomical difference.

Fischer considers that *Clathrella* is a transitional form between *Clathrus* and *Colus* which usually has a well-developed basal stem. Cunningham rejects *Clathrella* as a genus distinct from *Clathrus* on the grounds that a stemlike base may be present or absent in different plants of the same collection. In view, however, of the fact that the basal character is only one of the characters on which Fischer bases his genus and that equal if not more emphasis is placed on the presence of wartlike projections at the junctions of the arms to which the spore mass is restricted, there would appear to be some justification for the erection of *Clathrella* based on a combination of differences. It is therefore proposed, until such time as the South African phalloids are better known, to retain the genus *Clathrella*.

#### 5. CLATHRUS Micheli ex Persoon.

Synopsis Methodica Fungorum (1801) 241.

*Clathrus* § *Clethria* Fr., Syst. Myc. 2 (1822) 287.

*Ileodictyon* Tul., Ann. Sc. Nat., Ser. III, 2 (1844) 114.

Type Species : *Clathrus ruber* Mich. ex Pers.

Peridium subglobose or obovate, dirty white. Receptacle composed of a number of arms which fuse at intervals to form a hollow, spherical or egg-shaped latticed structure,

usually free at the base but occasionally attached to a shallow, substipitate, stemlike structure. Meshes polygonal and usually equal, occasionally somewhat elongated towards the base. Arms usually thick and massive, sometimes slender, not decreasing appreciably in thickness towards the apex; subtriangular to polygonal or sometimes elliptical in cross section, usually wrinkled, consisting of several layers of short, sometimes tubular cells, which frequently open on the inside. Spore mass mucilaginous, olivaceous, foetid, borne all over the inner sides of the arms. Spores smooth, tinted, bluntly elliptical (see Fischer in Nat. Pflanzenfam., 1933 : 84).

1. **Clathrus cibarius** (Tulasne) Ed. Fischer.

Jahrbuch der königlichen botanischen Gartens und botanische Museums zu Berlin, 4 (1886) 74.

Sacc. Syll. Fung. 7 (1888) 20; Lloyd, Myc. Writ. 3, Syn. Phall. (1909) 60, fig. 78, Myc. Notes 34 (1910) 447; Cunn. Gastero. Aus. and N.Z. (1944) 110.

*Ileodictyon cibarius* Tul., Ann. Sci. Nat., Ser. 3, 2 (1844) 114.

*Clathrus tepperianus* Ludw., Bot. Centralbl. 43 (1890) 7.

*Ileodictyon giganteum* Col., Trans. N.Z. Inst., 25 (1893) 324.

*Clathrus Higginsii* Bailey, Queensland Agr. Journ., 29 (1912) 48.

*Peridium* up to 7 cm. diam., subglobose to obovate, dirty white. *Receptacle* white, up to 15 × 10 cm. diam., subglobose to obovate, composed of brittle, spongy arms, which anastomose at intervals to form a sessile, clathrate structure. Arms elliptical or sub-cylindrical in section, cellular or sometimes tubular, not or only slightly thickened at the junction of the arms, transversely rugulose all round the arms. *Meshes* more or less polygonal. *Spore mass* deposited on inside of arms. *Spores* elliptical, 4–6 × 1.8–2.5  $\mu$  (sec. Cunningham), tinted, smooth.

*Habitat*: on ground in open places or under bushes.

*Distribution*: South Africa; Australia; New Zealand.

*Specimens examined*: on ground, Salisbury, Rhodesia, F. Eyles & Green (Eyles 4139; v. d. Byl 2346). Specimens at Stellenbosch.

*Specimens not seen*: on ground under bushes, Table Mt., Cape Town, MacOwan; Beatrice, S. Rhodesia, Eyles 4098.

This species has often been confused with *Clathrus gracilis*. It is of the same size, shape and colour, but differs in having sub-cylindrical rugose arms, which are not appreciably thickened at their junction with one another. An examination of alcohol-preserved material in sealed containers—the only specimens available for examination—indicated that the spore mass in *C. cibarius* is distributed all over the inside of the arms but is concentrated at the junction of the arms where there appeared to be protuberances. This point needs confirmation from fresh specimens.

*C. cibarius* is only known for certain from Southern Rhodesia. MacOwan's collection, of which no specimens have been found, was quite probably *C. gracilis*, the commonest phalloid and the only *Clathrus* found in the Cape peninsula.

Fischer places both *Clathrus cibarius* and *C. gracilis* in the genus *Ileodictyon*, erected by Tulasne for species with tubular, not chambered arms. Cunningham, however, discards this genus on the grounds that "the type species *C. cibarius*, contains plants with both tubular and cellular arms, small plants possessing tubular and large ones cellular arms".

2. *Clathrus gracilis* (Berkeley) Schlechtendal. [Plate XXV, fig. 1.]

*Linnaea* 31 (1861) 166.

G. H. Cunn., Gastero. Aus. and N.Z. (1944) 111; C. C. Brittlebank in Lloyd Myc. Writ. 4, L. 60 Note 395 (1915) 16.

*Ileodictyon gracile* Berk., London Journ. Bot. 4 (1845) 69.

*Clathrus albidus* Lothar ex. Fisch., in Sacc. Syll. Fung. 7 (1888) 20.

*C. intermedius* Fisch., Denkschr. Schweiz. nat. Gesell. 33 (1893) 20.

*Peridium* whitish, more or less oblong or obovate, 3-7 cm. diam. *Receptacle* white, often lop-sided, usually large, 4-13 cm. high, 5-9 cm. wide, sessile, free from the volva when fully expanded. *Meshes* large, up to 4 cm. diam. *Arms*, white, smooth or longitudinally ridged, flattened, ribbon-like, usually 3-5.5 mm. wide, but reaching 5-10 mm., including the fringed margin when present; consisting of one, two or more tubular chambers expanded at the fusion of the arms, sometimes conspicuously so, especially at the apex; margins of arms smooth or fringed. *Spore mass* distributed over the inner surfaces of the arms when expanded, mucilaginous, olive or sage green. *Spores* elliptical, smooth, tinted, 5-6  $\times$  1.8-2.5  $\mu$ . *Smell* rather like ensilage, described by Miss E. L. Stephens as "sweet with an underlying sourness; not foul like *Phallus* and *Anthurus*".

*Habitat*: in woods and open ground.

*Distribution*: Cape Peninsula in South Africa; Australia; Tasmania.

*Specimens examined*: Kirstenbosch, June 1917, *M. R. Levyns* (E.L.S. 167); Aug 1945, *R. H. Compton* (E.L.S. 569); in woods on slopes of Table Mt., Newlands, June 1929, *A. M. Bottomley* and *K. A. Lansdell* (E.L.S. 80); Groot Schuur Estate, Rondebosch, *J. Acocks* (E.L.S. 128); frequently collected by Miss E. L. Stephens in these localities during the last twenty years from June to August.

*Specimens not seen*: without locality. Lloyd (Myc. Writ. 3, Syn. Phall. 1909 : 62) mentions a very poor South African specimen at Paris labelled *C. Fischeri*, which he thought was *C. gracilis*. MacOwan records *C. cibarius* from Table Mt., Cape, but this was probably *C. gracilis* since the former is not known to occur in the area in question.

Miss E. L. Stephens of Cape Town University to whom I am indebted for most of my information about *C. gracilis*, states that this is the commonest phalloid in the Cape Peninsula. She considers the Cape plant a more robust and often larger form than the dried Australian specimen she saw at Kew.

*C. gracilis* is distinguished from other species by its white colour and flattened, ribbon-like arms.

3. *Clathrus* sp. [Plate XXVII.]

*Peridium* sub-globose, 2.3  $\times$  2.2 cm., white, splitting irregularly at the apex, attached by a stout mycelial cord. *Receptacle* obovate, 7-13  $\times$  5-8 cm., arms united at the base into a short, hollow, stemlike structure up to 1.5 cm. high, at first apricot colour, finally Cornelian Red at apex and Salmon Buff at base (colour of plant developed indoors from an egg). *Meshes* unequal, rounded elliptical to irregular polygonal, varying from 4 mm. diam. at apex to 2.5 cm. towards base. *Arms* rectangular to irregularly polygonal, 3.5 mm. wide, 3-4 mm. deep, enlarged or not at junction of arms, more or less flattened on outer surface, which is undulating to slightly rugulose with a slight to deep longitudinal groove down the centre, inner surface transversely rugulose without wartlike processes at the axils, partly tubular with one large tubular cell on the inner side and several smaller, often exteriorly perforated, short-tubular cells on the outside; margins of outer flattened surface

expanded at intervals into projecting points which give the arms a more or less fringed appearance. Spore mass mucilaginous, olivaceous, equally distributed on the inner side of all except the basal arms. Spores cylindrical, smooth, tinted,  $3\cdot5-5\cdot1 \times 1\cdot6-2\cdot2 \mu$  diam.

*Habitat* : on sandy or clayey soil in exposed positions, occurring singly.

*Specimens examined* : Wonderboom, Pretoria, 1926, A. O. D. Mogg, 23642 ; on dam wall, Loskop, Tvl., Dec. 1939, C. A. Blaeser, 31055.

It has not been possible to identify this species from literature and illustrations at my disposal, and the occurrence of single specimens only has made it impossible to get advice from overseas. The fringed arms suggest *Clathrus Clathrella Preussii*, recorded from the Cameroons, but from this species the local plant differs in colour and the absence of wartlike projections on the fusion points of the arms. From *C. cancellatus* (Lake Nyassa) it differs in shape, less rugulose arms and the presence of an external furrow ; from *Clathrella Baumii* (Zambesi) in the absence of projections at the arm junctions and the distribution of the spore mass ; from *Clathrus Fischeri* (Belgian Congo) in colour and less rugulose arms ; from *Clathrus camerunensis* in colour and more robust arms and, from the other local plant, determined by Fischer as near *Clathrella pseudocancellata*, in the presence of a fringed margin, the absence of axillary cushions which bear the spore mass and the shape of the meshes.

*Excluded species.*

**Clathrus camerunensis** P. Henn. [Plate XXV, fig. 2.]

Jahrb. der Botan. Museums zu Berlin, 1890 ; Sacc. Syll. Fung. 9 (1891) 264.

One collection of one specimen only, locality unknown, was sent to Lloyd by Dr. P. A. van der Byl of Stellenbosch for identification (Plate XXV, fig. 2). Lloyd named it *Clathrus camerunensis* (Myc. Writ. 5, Myc. Notes 53, 1918 : 754), adding that it was near *C. gracilis* of Australia. The outstanding feature of the plant was that it was white. Since *C. camerunensis* calls for a white plant with about 9 arms and very slender branches 1-4-2 mm. wide, it is unlikely that the South African plant with only 5 arms and these up to 5 mm. wide is the same plant. It is more likely to be the white species *C. gracilis*, commonly found in the Cape Peninsula.

**6. CLATHRELLA Fischer.**

in Engler & Prantl, Naturliche Pflanzenfamilien, 1 Abt.\*\* 1 (1900) 284 and 7a (1933) 87 ; Entwickl. Syst. Phall. Sec. III (1900) 35.

*Clathrus* auctt. pro parte.

Subs. *Clethria* P. Brown ex Corda, Icones Fungorum 6 (1854) 25.

Peridium subglobose or obovate, whitish. Receptacle composed of a number of arms which fuse at intervals to form a hollow, spherical, egg-shaped or obovate, latticed structure. Meshes polygonal, rarely round, usually more or less vertically elongated towards the base and often smaller at the apex. Arms cylindrical to flat strap-shaped, free or usually attached to a ring or short stemlike structure at the base, often decreasing in thickness towards the apex, tubular or consisting of only a few layers of chambers of which the innermost one is often larger and long tubular, furnished on the inside with a cushion-shaped projection at the fusion point. Cylindrical arms transversely rugulose all round, flattened arms finely transversely rugulose on the inner side. Spore mass mucilaginous, olivaceous, borne for the most part in small lumps on the wartlike projections at the junctions of the arms. Spores smooth, tinted, bluntly elliptical (see Fischer).

1. *Clathrella Baumii* (P. Henn.) Ed. Fischer.

Gasteromycetes in Engler, Die natürlichen Pflanzenfamilien 2 Aufl. Bd. 7a (1933) 89 (errore 'Cl. Braunii').

*Clathrus (Clathrella) Baumii* P. Henn. in H. Baum, Botanische Ergebnisse der Kunene-Sambesi Expedition (1903) 164; Sacc. Syll. Fung. 17 (1905) 213.

*Peridium* membranaceous, white, lobed, attached by a white mycelial cord. *Receptacle* oblong-ovoid, reticulated, divided at the attenuated, substipitate base into 5-6 arms, 6-10 cm. high, 3.5 cm. wide, golden-orange. *Arms* slender, 1-layered, tubular, anastomosed, plicate, 2-2.5 mm. broad. *Meshes* polygonal, oblong, 2.5 cm. long, 1.5 mm. wide, bearing on the inside at the axils, a wartlike process. *Spore mass* violaceous black, borne on the wartlike processes at the junctions of the arms. *Spores* oblong, fusoid or cylindrical, 4-5  $\times$  1.5  $\mu$  diam., hyaline. *Smell* foetid. (Description ex Sacc. Syll. Fung. l.c.)

*Habitat*: in sandy places in forests.

*Distribution*: Southern Africa.

*South African Record*: in forests on the Longa R., near Napalanka, Angola, Dec. 1899, Baum 601.

No specimens of this plant are available in South Africa for examination. Hennings (l.c.) states that this species is related to both *C. camerunensis* P. Henn. and *C. chrysomycelinus* A. Moell. but differs considerably from both in that in *C. Baumii* the spore mass is borne on small, wart-like cushions about 1-2 cm. broad on the fusion points of the upper arms.

2. *Clathrella* cfr. *pseudocancellata* Ed. Fischer. [Plate XXVI, fig. 1, 2.]

Untersuch. Phalloideen III (1900) 36; Sacc. Syll. Fung. 16 (1902) 228.

*Peridium* 3-5  $\times$  2-3 cm. diam., subglobose, white, splitting irregularly at the apex rooting by a stout, branched, white mycelial cord. *Receptacle* 5.75-9.5 cm. high, 4.5-8 cm wide, subglobose or obovate, usually tapering towards the base, where the armlike processes which anastomose at intervals to form a hollow, spherical, network structure, are united into a short, hollow, stemlike base; reddish-orange or yellow to salmon. *Meshes* 2-4 cm. diam., polygonal, more or less equal or smaller at apex, somewhat vertically elongated towards the base. *Arms* 1.5-8 mm. diam. (pressed specimens), round to rounded triangular, tubular or partly tubular, with one large, continuous tubular cell on the inner side and 2-3 layers of smaller cells on the outside, somewhat tubercular or transversely rugulose on the outside, more strongly transversely rugose on the inner side; thicker and more cellular at the junction of the arms, where a rough, cushion-like structure projects slightly. *Spore mass* olive green, mucilaginous, foetid, borne on the inner surface of the arms—to some extent all over, but principally on the wartlike cushions at the junction of the branches. *Spores* bluntly cylindrical, smooth, tinted 4-5  $\times$  2-4  $\mu$ .

*Habitat*: in sandy soil, damp ground and grass lawns, occurring singly as a rule.

*Distribution*: Central Africa (Lake Nyassa); South Africa, Rhodesia and Transvaal.

*Specimens examined*: under citrus tree, de Wagen Drift, nr. Premier Mine, Jan. 1918, A. M. Bottomley, 11231; under bush, Pretoria, March 1917, J. Wickens, 10058; Salisbury, Rhodesia, March and December 1921, F. Eyles 2983, det. Ed. Fischer, 15527; Pretoria, Vos, Feb. 1937, 28777; Pretoria North, Jan. 1941, E. Anderssen, 33333.

The above species is the most common phalloid in the Transvaal. Pickled specimens of the Rhodesian collection (Eyles 2983) were submitted to Fischer for identification, but he was unable to name them exactly. He suggested that this plant was nearest *Clathrella*

*pseudocancellata*, from which, however, it differed in that the arms were not smooth and ribbon-like, the colour was yellow to salmon instead of reddish orange (reddish-orange plants are common in the Transvaal) and there was no short, stemlike base (this structure is present in some specimens of the same collection kept in Pretoria). Fischer considered that the plant belonged to *Clathrella* on account of the knoblike outgrowths at the junction of the arms of the network. He suggested that possibly *Clathrus Fischeri* Pat. & Har. (Bull. Soc. Myc. France 9, 1893 : 211) collected in the Congo, was the same plant. The latter species is, however, much longer, up to 18 cm. high, and is entirely white.

Judging from descriptions, the South African plant appears to be more nearly related to *Clathralla Baumii* P. Henn., found in Angola. With this it agrees in colour, size, shape of the meshes and presence of wartlike cushions at the junction of the arms, but differs in that the arms are not always tubular. According to Cunningham, however, this character is variable.

Until more intensive work has been done on the phalloids in South Africa, the name of the plant described is left as suggested by Fischer, viz. *Clathrella* cfr. *pseudocancellata*.

#### 7. KALCHBRENNERA Berkeley.

in Gardener's Chronicle, N. Ser., 5 (1876) 785 ; Trimen's Journ. Bot. 14 (1876) 218.

Peridium subglobose, splitting circumscissilely near the apex. Receptacle hollow with spongy, chambered walls, cylindrical or club-shaped, terminating in a dome-shaped clathrate structure, which gives rise to a number of radiating, simple or forked processes. Spore mass borne on clathrate structure and processes.

Type species : *Ralbrennera corallocephale* (Welw. & Curr.) Kalchbr.

*Distribution* : South Africa.

***Kalchbrennera corallocephala* (Welwitsch et Currey) Kalchbrenner.** [Plates XXIII, XXIV.]  
Phalloidei novi vel minus cogniti (1880) 20 ; Ed. Fisch. Untersuch. Phalloideen (1890) 18.

*Lysurus corallocephalus* Welw. et Curr., Trans. Linn. Soc. London 26 (1868) 287.

*Kalchbrennera Tuckii* (Kalchbr. et MacOwan) Berk., Gard. Chron. n.s. 5 (1876) 785 ; Trimen's Journ. Bot. 14 (1876) 218 ; Kalchbr., Phall. novi vel minus cogniti (1882) 106 ; Sacc. Syll. Fung. 7 (1888) 14.

*Kalchbrennera Tuckii* var. *microcephala* Pole Evans, Records Albany Mus. 3 (1915) 159.

? *Kalchbrennera Tuckii* var. *clathroides* P. Henn., Fungi Camerunensis in Engl. Bot. Jahrb. 22 (1895) 108.

Peridium up to 6.5 cm. high and up to 5 cm. wide, globose, finally obovate, smooth or minutely furfuraceous, splitting irregularly and circumscissilely just below the apex, the upper portion remaining on the top of the receptacle as a cap, until pushed off by the expanding processes ; white, becoming tinged with yellow when handled ; strongly rooting by a thick, white, cordlike structure. Receptacle cylindrical or club-shaped, terminating in a hollow, dome-shaped clathrate structure, sometimes demarcated from the stem by a sudden change of colour, or by a slight constriction caused by a reduction in the number of layers of cells in the stem wall. Stalk 3.5-11 cm. long, 0.5-1.5 cm. wide just above base which is narrowed rather abruptly to a blunt point, increasing in size up to 3.5 cm. at the apex, finally hollow, at first filled with a transparent gelatinous substance ; wall consisting of 2-3 chambers which are more or less long and tubular ; closely and finely rugulose, the rounded surface of the wrinkles sometimes externally perforated and the deep

folds sometimes forming almost complete transverse walls across the tubular chambers; white, brownish white or pale yellow (Capucine Buff) at base, deepening in colour towards the apex to a pinky orange (Salmon Orange) or sometimes to the red colour of the clathrate dome. *Clathrate structure* sealing-wax red in colour, consisting of a number of deeply transversely rugulose arms up to 6 mm. diam. and 1-3 chambered, which arise from the apex of the stem and fuse together at intervals to form a number (up to 15 counted) of usually small, irregularly rounded, elliptical or polygonal, thick-walled meshes. The walls of the latter give rise to a number (up to 16 counted) of long or short processes 3.5-10 cm.  $\times$  2-7 mm.; these are radiating, free, concolorous, simple, apically branched or dichotomously forked with, usually, blunt, nail-shaped ends (said by Kalchbrenner, i.e., to resemble the forked thorns of *Carissa arduina* Lam.). These processes, like the arms of the clathrate structure, are one to several chambered, deeply transversely rugulose and cylindrical or depressed below. *Spore mass* sage green, then greenish black, covering all rugulose structures. While still in the egg stage, the gleba completely fills the interstices between the processes, the apices of which are visible on the compact spore mass as scattered, white or red (depending on the stage of development) more or less regular, crescent-shaped, flattened, coraloid structures with open surface cells. *Spores* elliptical, smooth, tinted, 3.4-1.5  $\mu$  diam. *Smell* strong and foetid.

*Habitat* : on ground in wooded thickets, open places or cultivated fields and gardens; occurring singly or in groups after prolonged rains.

*Distribution* : South Africa.

*Specimens examined* : Sydenham, Natal, 1882, *J. Medley Wood* 665, 10388, 13075, 31825, Kew as *K. Tuckii*; Boschberg Mts., nr. Somerset East, C.P., 1876-78, *P. MacOwan* & *Tuck* (MacOwan 1225, S.A.M. 34318) 22050, Kew as *K. Tuckii*; Amabele, C.P., Jan. 1915, *P. v. d. Byl*, 8954; Grahamstown, Feb. 1915, *S. Schonland*, 8952, type of *K. Tuckii* var. *microcephala*, 8953; Kentani, *A. Pegler* 1424, 8848 as *K. Tuckii* var. *microcephala*, Kew; Umkomaas, Natal, April 1919, *V. Bottomley*, 11861; Malcomess, Knapdaar, C.P., April 1926, *Gideon Joubert*, 20842; Jacksonstuin, Brits, Tvl., Nov. 1936, *A. O. D. Mogg*, 28730; Bathurst, C.P., April 1930, *B. Hahne*, 25367; Brenton, Knysna, *A. V. Duthie* 79, (E.L.S. 418) 31337; Bedford, C.P., *R. Marloth*, 26590; Umtata, *A. Abernethy*, Feb. 1940, 34148; nr. Bedford, C.P., Dec. 1879, *C. Trollip* (S.A.M. 31319); in sandy soil, Bellville, July 1939, *J. Lippett* (E.L.S. 553); Durban, *P. v. d. Byl* 359; Maciene, Mocambique, June 1928, *E. L. Stephens* 15; George, March 1934, *D. McIntyre* (E.L.S. 279); Pinelands, Capetown, June 1932, *E. L. Stephens* 129; nr. Melkbosch Strand, C.P., Aug. 1944 and 1945, *A. Salkeld*, a collection of 40 to 50 specimens (S.A.M. 56361); Barberton, Tvl., March 1941, *J. Rowland*, 32887.

*Specimens not seen* : Kentani, *Pegler* 1423, Kew; nr. Engeboho, Tambukiland, *Woolby*; Botanic Gardens, Durban, *Medley Wood*, Kew; Durban, *v. d. Byl* 359; Riversdale, C.P., *Muir* (*v.d. Byl* 2603); Krantskloof, Natal, *Medley Wood* 812 as *K. Tuckii*; Pungo Ondonga, Angola, Dec. 1856, *Welwitsch* 119; Bathurst, *B. Liebenberg*, Oct. 1930.

Although this plant varies considerably in size, number of cavities and processes in the clathrate dome and in the length and shape of the processes, it is easily recognised by its well developed stalk, which terminates in a brilliant, red, dome-shaped, clathrate structure, on which arise a number of concolorous, free, radiating, simple or apically branched or forked, coraloid processes. In collection No. 8848, one specimen is only 1.5  $\times$  1 cm. in size and has only a few obscure cavities and processes, the latter being little more than knob-like expansions of the cavity walls. In collection No. 8954 on the other hand, the processes were described by Dr. Pole Evans (i.e.) as "slender, tapering, and almost whip-like in appearance, instead of blunt and nail-shaped" (the preserved specimen is very much shrunken and no longer shows such extreme characters).

*Kalchbrennera Tuckii* v. *microcephala* was separated from the type, on the grounds of smaller size and short processes, but these characters vary so much in different collections that they are not considered of sufficient importance to constitute a separate variety.

*K. Tuckii* var. *Clathroides* described by P. Hennings (l.c.) as resembling a stalked *Clathrus* is probably a *Simblum*.

I am indebted to Miss Lewis of the South African Museum, Cape Town, for a full range of specimens of *K. corallocephala*, collected by Mr. A. Salkeld, showing all stages of development, as well as for some excellent coloured sketches. From these the above description was made.

## SCLERODERMALES.

Plants usually finally epigeous, sessile or contracted into a stem-like base. Peridium of one, two or three layers, directly enclosing the gleba, dehiscing either by an apical pore or by irregular splitting, usually of the apical portion. Gleba without true capillitium threads, becoming pulverulent at maturity. Basidia 4-8-spored. Spores globose or elliptical, hyaline or coloured, smooth or rough, pedicellate or not.

The chief characters on which this order is separated from other orders are the absence of capillitium threads and the pulverulent nature of the mature gleba.

Cunningham included the two families CALOSTOMATACEAE and SCLERODERMATACEAE in this order, the former represented by a single genus, *Calostoma*, which has so far not been found in South Africa, and the latter by two genera, *Scleroderma* and *Pisolithus*, both of which commonly occur in this country. In the present work, the ARACHNIACEAE has likewise been included in this order, mainly on account of the important characters it has in common with the above two families, namely the absence of true capillitium threads and the pulverulent nature of the mature gleba. *Arachnion*, the only well-defined genus in the family, is fairly well represented in South Africa.

## Key to the Families.

Peridium borne on a well developed stem-like base, 3-layered, dehiscing by an apical pore. Gleba at maturity carried within the endoperidium, which is attached to the apex of the peridium.....

Peridium sessile or with a stem-like base, 1-2-layered, dehiscing by irregular splitting of the apical portion. Gleba at maturity pulverulent, free within the peridium or in small chambers formed by persistent tramal plates.....

Peridium sessile, 1-layered, dehiscing by disintegration of the apical portion. Gleba at maturity pulverulent, consisting of peridioles lined with a hymenial layer, to which the spores are attached.....

(Calostomataceae).

Sclerodermataceae.

Arachniaceae.

## SCLERODERMATACEAE Fischer.

Naturlichen Pflanzenfamilien 1, 1\*\* (1900) 334.

G. H. Cunningham, Gastero. (1944) 115.

Plants usually epigeous, seldom entirely or partly subterranean, more or less globose, sessile or with a stem-like, rooting base. Peridium of one or two layers, dehiscing by irregular splitting of the apical portion. Gleba finally pulverulent, consisting of a mass of spores permeated by tramal plates, which either break down and become pulverulent or form the persistent walls of small chambers enclosing a mass of spores. Capillitium wanting. Spores usually globose, coloured, echinulate or reticulated. Basidia 2-8-spored.

Two genera only are included in this family—*Scleroderma* and *Pisolithus*—both of which are common in South Africa. They are separated from each other mainly on the following characters:—

Tramal plates of the gleba permeating the mass of spores but finally breaking down and with the spores forming a pulverulent mass.....

Tramal plates forming persistent walls of small chambers which enclose masses of finally pulverulent spores.....

1. *Scleroderma*.2. *Pisolithus*.

## 1. SCLERODERMA Persoon.

Synopsis Methodica Fungorum (1801) 159, pro parte, emended Fries, Systema Mycologicum 3 (1829) 44.

Fischer, Nat. Pflanz. 7a (1933) 36; Verwoerd, Ann. Univ. Stell. 3 (1925) 17;

G. H. Cunningham, Gastero. (1944) 114.

*Sclerangium* Lév., Ann. Sci. Nat., ser. 3, 9 (1843) 132.

*Stella* Mass., Journ. Myc. 5 (1890) 185.

*Nepotatus* Lloyd, Myc. Writ. 7, Myc. Notes 75 (1925) 1355.

Type species: *Scleroderma aurantium* Pers.

Plants globose, subglobose, depressed globose, pyriform, usually epigeous at maturity, sessile or contracted into a small to well-developed, stem-like base, attached by a mass of mycelial threads. Peridium smooth, areolate, squamose or warted, thick or thin. Gleba consisting of a mass of spores permeated by tramal plates, which finally become pulverulent. Spores coloured, large, globose or sometimes subglobose, usually strongly echinulate or less often reticulated.

Of the sixty or more species described for this genus, Cunningham (l.c., p. 110) considers that not more than about a dozen are good, the others being either synonyms of these or of *Mycenastrum*, with which *Scleroderma* has often been confused. About a dozen species have been recorded for South Africa and of these four have been definitely established as being distinct species. Several other species described or recorded may be distinct, but further study and comparison of specimens is necessary. This is rendered difficult by the terms of bequest of the van der Byl collections, under which specimens may not be removed from his herbarium.

#### Key to the Species.

Spores echinulate.

Dehiscence by irregular cracking of the apical portion.

Peridium typically smooth or becoming apically areolate or squamose.. 1. *S. cepa*.

Peridium typically covered with dark, evenly distributed squamules or scales..... 2. *S. verrucosum*.

Dehiscence by splitting into several segments from the apex downwards, in a stellate manner. Stemlike base usually well developed..... 3. *S. flavidum*.

Spores reticulated.

Dehiscence by irregular cracking of the apical portion.

Peridium hard and woody when dry..... 4. *S. aurantium*.

Peridium thin, pliant and brittle when dry..... 5. *S. bovista*.

Dehiscence by splitting into several segments, from the apex downwards, in a stellate manner..... 6. *S. geaster*.

#### 1. *Scleroderma cepa* Persoon. [Plate XXVIII, fig. 1; Plate XXIX, fig. 1.]

Synopsis Methodica Fungorum (1801) 706.

Verwoerd, Ann. Univ. Stell. 3 (1925) 18; Coker & Couch, Gastero. (1928) 167.

Plants 1-8 cm. diam., subglobose, depressed globose, pyriform, irregularly compressed when caespitose, sessile or nearly so, attached by a mass of white mycelial threads. Peridium Pinkish Buff, pale brown, ochraceous (between Honey Yellow and Olive Ochre), usually smooth when fresh, often becoming squamose or areolate, or occasionally warted in the apical part, the squamules inherent and almost concolorous, rather thick at first, drying to 1 mm. or less, finally leathery, rather brittle but not very hard, not discolouring to any extent when cut; sterile base if present, scanty, becoming yellowish when cut; dehiscing by irregular splitting in the apical portion. Gleba watery white at first, but soon nearly black with a violet tinge, finally olivaceous grey or stone grey with a violaceous tinge. Tramal Plates yellow or greyish. Spores globose or less often subglobose, strongly and long echinulate, 10·2-15·3  $\mu$  diam., common size 11·9-13·6.

Habitat: under trees, hedges and in open places, solitary, gregarious or caespitose.

Distribution: South Africa; North America.

*Specimens examined* : under *Populus* spp., Fountains Valley, Pretoria, March 1936, *K. Lansdell & A. M. Bottomley*, 28587, *N. Parkes*, 21095, March 1927, *L. Reinecke*, 21215; Wonderboom, Pretoria, Nov. 1936, *E. M. Dodge & A. M. Bottomley*, 28725, Jan. 1917, *H. V. King*, 10056, Feb. 1928, *E. M. Dodge*, 23168; Mazelsoort, Bloemfontein, May 1945 *P. H. B. Talbot*, 35402. Under *Pinus* spp., Meintjes Kop, Pretoria, March 1921, *A. M. Bottomley*, 14514, March 1925, 20389; Pretoria, April 1930, *M. Bosman*, 29436. Under *Salix* spp., Pyramids, Pretoria, Feb. 1939, *A. Hean*, 30999; Garstfontein, Pretoria, April 1911, *P. J. Pienaar*, 1338, 1349. Under *Eucalyptus* spp., Pretoria, Jan. 1928, *L. Reinecke*, 23141. Under *Quercus* spp., Belvidere, Knysna, *A. V. Duthie*, 31388; attached to roots of *Quercus* seedling, Johannesburg, March 1936, *Superintendent of Handicrafts*, 28585. Under hedge, Riviera, Pretoria, April 1945, *E. Schaefer*, 35401, Feb. 1946, 35400. Situation not indicated, Riviera, Pretoria, May 1916, *L. Kresfelder*, 9794, 9774; Rietfontein, Pretoria, April 1921, *L. Venter*, 14493; Pretoria, Jan. 1919, *E. M. Dodge*, 11810; Johannesburg, Dec. 1914, *A. M. Bottomley*, 8771; East Rand, *G. Marquardt*, 14485; Pietermaritzburg, Natal, April 1911, *I. B. Pole Evans*, 1342, 1343, 1347, 1356, 1358; Empangeni North, Natal, June 1917, *P. v. d. Byl* (N.H. 672), 31886; Mamathes, Basutoland, Feb. 1941, *A. Jacot-Guillarmod*, 33495; Aliwal North road, Jan. 1946, *R. A. Dyer*, 33518; Stellenbosch, C.P., *Duthie* 274 (v. d. Byl 1967 as *S. vulgare*) 31447; Oct. 1945, *M. P. de Vos*; *A. V. Duthie* § 39, 31517; The Flats, Stellenbosch, June 1921, *A. V. Duthie*, 31469; Ida's Valley, Stellenbosch, Nov. 1924, *A. V. Duthie*, 35407; Knysna, C.P., *A. V. Duthie*, 31401, Jan. 1921, *A. V. Duthie*, 35403, *Duthie* 111, 31354; Toise River, C.P., March 1912, *P. J. Pienaar*, 2276; Kirstenbosch, C.P., June 1929, *Prof. Compton*, 24835, June 1921, *V. A. Putterill*, 14835, Jan. 1939, *E. L. Stephens* 431, 35514, April 1939, *E. L. Stephens* 468, 35440, May 1938, *A. J. Middlemost* (E. L. Stephens 467) 35515, April 1939 (E. L. Stephens 477) 35517; Rondebosch, *E. L. Stephens* 154, 35512; Stikland, C. P., March 1932, *J. Acocks* (E. L. Stephens 112) 35511; without locality, *E. L. Stephens* 470, 35516; Zululand, *P. v. d. Byl* 556; Natal, *v. d. Byl* 288; Nottingham Road, Natal, *v. d. Byl* 557; Stellenbosch, *v. d. Byl* 810, 812, Aug. 1922, *v. d. Byl* 893; Salisbury, S. Rhodesia, April 1926, *Eyles* 4091 (S.Rh. 3834).

*Specimens not seen* : University grounds, Rosebank, various dates, *E. L. Stephens* 78, June 1931, *E. L. Stephens* 79, May 1940, *E. L. Stephens* 524; in greenhouse, April 1941, *E. L. Stephens* 559; Brackenfell Hill, May 1932, *J. Acocks* (E. L. Stephens 118).

This species appears to be the most common so far encountered in South Africa. It is recognised by the usually smooth surface, the lack of, or scanty stem-like base and the comparatively thin mature peridial wall.

## 2. *Scleroderma verrucosum* (Bulliard ex Persoon) Persoon.

[Plate XXVIII, fig. 2;  
Plate XXIX, fig. 2.]

*Synopsis Methodica Fungorum* (1801) 154.

*Sacc. Syll. Fung.* 7 (1888) 136; *Verwoerd, Ann. Univ. Stell.* 3 (1925) 18; *G. H. Cunningham, Gastero.* (1944) 119.

*S. areolatum* Ehrenb., *Sylv. Myc. Berol.* (1818) 27.

*S. pandanaceum* F. v. Muell., *ex Berk. Journ. Linn. Soc.* 13 (1872) 171.

*S. Bresadoliae* Schultz, *Hedwigia* 23 (1884) 163.

*S. Torrendii* Bres., *Atti I.R. Acc. Sci.* 8 (1902) 132.

Plants 1-8 cm. wide, up to 4.5 cm. high exclusive of the stem-like base, subglobose, depressed globose, pyriform or irregularly compressed if caespitose, abruptly contracted below into a well developed, lacunate, furrowed or smooth stem-like base, which is attached to the substratum by a mass of mycelial threads. Peridium pinkish Buff, pale brown, pale ochraceous, yellowish brown, bay brown or umber, typically covered with brown

## SCLERODERMA.

squamules or flattened warts; squamules or warts small to 2 mm. diam., fairly closely and more or less evenly distributed, darker brown than the peridium, usually larger in the basal half and sometimes slightly sunk in more or less well defined areolae; dehiscing by a small, torn, apical aperture, which splits irregularly in different directions. *Stem-like base* small to larger than the fertile part, in the latter case thick, solid, white, remaining unchanged or turning pinkish brown when cut, thin, becoming less than 0.5 mm. when dry, in section white at first, becoming pinkish brown when dry. *Gleba* white, soon turning sooty black with a violet tinge, finally stone grey, greyish brown, with or without an olivaceous tinge. *Tramal plates* white, then greyish and inconspicuous in the mature mass. Spores 8.5-13.6  $\mu$  diam., occasionally up to 17  $\mu$  diam., globose, coarsely and densely echinulate, dark greyish brown, mixed with hyphal remains.

*Habitat* : under trees, hedges or in the open, solitary, gregarious or caespitose.

*Distribution* : North and South Africa; Asia Minor; Australia; Britain; Europe; India.

*Specimens examined* : under *Populus* sp., Garstfontein, Pretoria, Feb. 1919, *E. M. Doidge*, 30702; Fountains, Pretoria, Feb. 1928, *E. M. Doidge*, 35406, March 1936, *A. M. Bottomley & K. A. Lansdell*, 35405; under hedge, Pretoria, Feb. 1946, *E. Schaefer*, 35404 Pietermaritzburg, Natal, April 1911, *I. B. Pole Evans*, 1345, Kew, Feb. 1915, *J. M. Smith*, 8816; Stellenbosch, May, *A. V. Duthie* 13 (v. d. Byl 1185) 31300. Under *Quercus* p., Belvidere, Knysna, C.P., *A. V. Duthie* 212 as *S. tenerum* B. & C., 31369, Jan. 1921, *A. V. Duthie* 278 as *S. tenerum*, 31451; Mamathes, Basutoland, Feb. 1941, *A. Jacot-Guillermot* 33496; Kirstenbosch, March 1932, *E. L. Stephens* 107.

*Specimens not seen* : Salisbury, S. Rhodesia, *F. Eyles* 4141; Hogsback, *N. J. G. Smith*, Kew; Capetown, *MacOwan*, Kew.

This species is recognised by the thin, pale brown or yellowish, peridial wall, covered with small, evenly distributed, darker brown squamules or flattened warts. The dark brown scales against the paler background make a striking contrast.

3. *Scleroderma flavidum* Ellis et Everhart. [Plate XXX, fig. 1-2; Plate XXXI, fig. 3.]  
Journal of Mycology 1 (1885) 88.

Coker & Couch, Gastero. (1928) 162; Verwoerd, Ann. Univ. Stell. 3 (1925) 17; G. H. Cunningham, Gastero. (1944) 120.

*Scleroderma caespitosum* Lloyd., Myc. Writ. 7, Myc. Notes 67 (1922) 1159.

*S. flavidum* var. *fenestriatum* Clel. & Cheel., Trans. Roy. Soc. S. Aus. 47 (1923) 75.

*S. rhodesica* Verwoerd, S.A. Journ. Sci. 23 (1926) 292.

Plants, unexpanded 1.5-6 cm. diam., expanded 2.5-14 cm. diam., subglobose, depressed globose, pyriform, smooth or plicate below, usually contracted into a well developed stem-like base. *Peridium* up to 5 mm. thick becoming much thinner when dry, hard, tough, woody, usually smooth to areolate at the apex or cracking into flattened warts, bright or dull ochraceous yellow, often becoming darker with age; usually dehiscing by irregular splitting, from the apex downwards, into 5-11 unequal or subequal lobes, which remain erect, with or without recurved tips, or become expanded in a stellate manner with recurved tips. *Gleba* olivaceous, finally umber, ochraceous brown, often disappearing completely at maturity, leaving the cup-shaped peridium empty. *Tramal plates* yellow, finally greyish and inconspicuous. Spores globose, densely echinulate, 7-12  $\mu$  diam.

*Habitat* : on the ground.

*Distribution* : Africa; North America; Australia; New Zealand.

*Specimens examined* : Potchefstroom, March 1939, *M. Gunn*, 30513; Meintjes Kop, Pretoria, April 1925, *A. M. Bottomley*, 20414; Parys, O.F.S., April 1936, *E. M. Dodge*, 28601; without locality, *E. L. Stephens* 223, 34530; Stellenbosch, Oct. 1945, *M. P. de Vos*; Rietvlei, Pretoria, March 1945, *A. M. Bottomley*, 35399; Magaliesberg Mts., Rustenburg, June 1928, *W. Dobie*, 23380; Riviera, Pretoria, May 1916, *L. Kresfelder*, 9773; Mooibank, Potchefstroom, Nov. 1929, *H. A. Lawrence*, 24885; Fountains Valley, Pretoria, March 1924, *A. M. Bottomley*, 20466; Kirstenbosch, C.P., June 1929, *K. A. Lansdell*, 24824; Meintjes Kop, Pretoria, May 1925, *A. M. Bottomley*, 20583; under *Eucalyptus* trees, Potchefstroom, July 1935, *J. Sellschop*, 28516, April 1925, *M. Radloff* (v. d. Byl 2093); Under *Pinus* sp., Stellenbosch, June 1924, *L. Verwoerd* (Stell. 9; v.d. Byl 1966); on ground, Kirstenbosch, June 1924, *L. Bolus* (v. d. Byl 1668); on ground, Pietersburg, Tvl., April 1930, *I. B. Pole Evans*, 25424; on banks of Umsinduzi River, Pietermaritzburg, April 1911, *I. B. Pole Evans*, 1555; Salisbury, S. Rh., *F. Eyles* 4133 (S. Rh. 4030) co-type *S. rhodesica* Verwoerd.

*Specimens not seen* : Klein Drakenstein, v. d. Byl 2543; Bloemfontein, Verwoerd.

This species is recognised by the yellow colour, usually smooth, sometimes apically areolate, relatively thick, hard peridial wall, stellate manner of dehiscence and often finally empty peridium, due to the disappearance of the gleba. It differs from *S. geaster*—a species not so far definitely established as occurring in South Africa—which dehisces in a similar manner, in its usually smaller size, smoother peridium and the larger spores with longer spines and no reticulum.

4. ***Scleroderma aurantium* (Vaillant) Persoon.** [Plate XXXI, fig. 2.]

*Synopsis Methodica Fungorum* (1801) 153.

Hollós, Gastero. *Ung.* (1904) 131; Coker & Couch, Gastero, (1928) 168.

*Lycoperdon cervinum* Bolton, *Fung. Fasc. III* (1799) 39.

*Scleroderma vulgare* Hornem. *Flora Dan.* (1829) t. 1969; Verwoerd, *Ann. Univ. Stell. 3* (1925) 18.

*S. citrinum* Pers., *Syn. Meth. Fung.* (1801) 153.

*S. squamosum* Chev., *Flor. Paris* (1826) 357.

Plants 1·5-5 cm. diam., epigeous, depressed globose, contracted or pinched below into a small or large stem-like base, which is attached to the substratum by a mass of mycelial threads. *Peridium* hard and woody when dry, about 2 mm. thick when fresh, drying to about 0·5 mm., yellow, ochraceous or pale brown, smooth or apically simply areolated, or areolated with central warts or finely or grossly warted; dehiscing by irregular cracking of the apex. *Gleba* chocolate brown, olivaceous umber, violaceous grey. *Tramal plates* white, then yellow or greyish, usually conspicuous. *Spores* globose, dark brown, reticulated, 13·6-17·0  $\mu$  diam., including the reticulations, the tips of which are connected by an entire or broken hyaline halo. In the latter case, the edges of the reticulations, seen under the microscope as long spines around the spore, appear to be apically branched.

*Habitat* : on ground, solitary.

*Distribution* : North and South Africa; North America.

*Specimens seen* : Kloof, Natal, April 1940, *Dr. Bonfa*, 33571; Nottingham Road, Natal, April 1917, *P. v. d. Byl* (N.H. 538) 31805.

*Specimens not seen* : Bloemfontein, *L. Verwoerd*; Salisbury, *Eyles* 409 (v. d. Byl 2351); Cape, *MacOwan* 1454, Kew,—all as *S. vulgare*.

The above description is based on two collections only. These specimens differ from the typical form occurring elsewhere in the surface of the peridium and in the size of the spores. They are smooth or wrinkled instead of covered apically with warts or scales and the spores are larger than those of the European and North American plants, being  $13\cdot6$ - $17\cdot0$   $\mu$  including the reticulations, instead of  $8\cdot5$ - $10\cdot2$   $\mu$  recorded by Coker & Couch (l.c.) or  $9\cdot5$ - $13$   $\mu$  mentioned by Hollós (l.c.). These differences do not appear to justify a new species, especially as the spores are typically reticulated, a rather unusual feature.

The species is recognised by the yellow colour, the hard, thick peridial wall, and particularly the reticulated spores.

##### 5. **Scleroderma bovista** Fries.

*Systema Mycologicum* 3 (1829) 48.

Hollós, Gastero. *Ung.* (1904) 133; Coker & Couch, Gastero. (1922) 164; G. H. Cunningham, Gastero. (1944) 117.

*S. texense* Berk., *Lond. Journ. Bot.* 4 (1845) 308.

*S. columnare* Lloyd, *Myc. Notes* (1918) 759.

Plants 0.7-2 cm. diam., subglobose, depressed globose or irregular by pressure when caespitose, sessile or almost so, pinched below into a dense mass of whitish mycelial threads. *Peridium* becoming thin and brittle at maturity, ochraceous brown, bay brown or umber, smooth or becoming apically finely areolated, dehiscence by irregular cracking at the apex. *Gleba* ochraceous to olivaceous. *Tramal plates* yellowish, more or less persistent, the fragmented plates often resembling poorly developed capillitium threads. *Spores* globose, olivaceous to olivaceous-brown,  $10\cdot14$   $\mu$  diam., coarsely reticulated, the reticulations projecting at the margin like blunt, finger-like processes, usually partly, if not entirely connected by a hyaline halo.

*Habitat*: solitary or caespitose in ground.

*Distribution*: South Africa; North America; Australia; Europe; India; New Zealand.

*Specimens examined*: in manured flower garden, Salisbury, S. Rhodesia, Jan. 1939 (S.R.M.H. 4277).

The species is characterised by its thin, pliant but brittle peridium, more or less persistent tramal plates and coarsely reticulated spores. It differs from *S. aurantium* mainly in the texture of the peridium which in the latter case is hard and woody.

##### Doubtful or insufficiently known Species.

###### **Scleroderma capensis** Lloyd.

*Mycological Writings* 7 (1924) 1305.

Plants small, 6-15 mm. diam., subglobose, sessile, attached by a mass of fine mycelial threads. *Peridium* ochraceous brown, smooth to minutely cracked and roughened, thin and brittle. *Gleba* reddish brown. *Tramal plates* yellow, becoming inconspicuous in mature gleba. *Spores* globose, strongly echinulate,  $8\cdot5$ - $13\cdot6$   $\mu$ , common size  $10\cdot2$   $\mu$ , free of hyphal debris.

*Habitat*: in clayey soil, largely subterranean.

*Distribution*: South Africa.

*Specimens examined* : Stellenbosch, *Duthie* 327 (Lloyd Myc. Coll. 24894, Type) 31489, part of type collection.

This species, of which only three specimens are available for examination, resembles a small *Scleroderma cepa* with reddish brown gleba and usually smaller spores. Since both these characters are variable, there do not seem sufficient grounds on which to erect a new species. Further collections are necessary to settle this point. Lloyd (l.c.) advanced no sound reasons for his new species. He names the small size, different appearance of the gleba and freedom of the spores from hyphal remains as the differences between this species and others.

**Scleroderma laeve** (Léveillé nom. nud.) Lloyd.

Lloyd, Mycological Writings 5, Letter no. 63, Note 468 (1916) 11.

Lloyd (l.c.) writes in connection with the only South African record of this species :—

“ *Scleroderma laeve* from Miss A. V. Duthie, South Africa. The name is based on a specimen so named by Léveillé, at Paris, which never broke into print. As to shape, rooting base and thin peridium it corresponds to *Scleroderma verrucosum* but has a smooth peridium. In my opinion it is a smooth form of *Scleroderma verrucosum*.”

No specimen is available for examination and it is therefore not possible to make any comment on the above note. If, as Lloyd suggests, the specimen, *Duthie* 118, is a smooth form of *S. verrucosum*, the case is parallel with that of the South African form of *S. aurantium*, which is smooth to wrinkled, whereas the typical form found elsewhere is rough.

**Scleroderma lejospermum** (Montagne) de Toni.

Saccardo Sylloge Fungorum 7 (1888) 140.

*Mycenastrum lejospermum* Mont., Enum. Fung. (1847) 175; Sac. Syll. Fung. 7 (1888) 140.

Peridium . . . *Capillitium* colour of powdered rhubarb. Spores quite smooth, brown, hyaline, shortly pedicelled, containing an oil drop occupying almost half of the diameter. (Description from Saccardo of *Mycenastrum lejospermum* Mont.)

*Habitat* : in dry places.

*South African record* : Witpoortberg, S. Africa, *Drege* 9466.

It is very unlikely that the specimen on which this record was based was either a *Mycenastrum* or a *Scleroderma*, since neither of these genera has smooth spores. In the absence of a description of the peridial characters it is impossible to suggest what genus, much less species, it could be. No specimen is available for examination.

**Scleroderma pyramidatum** Kalchbrenner.

Grevillea 10 (1882) 109.

“ *Globosum* (2 poll. et ultra diam.) brevissime stipitatum, areolatum, areolis elevatis pyramidulas truncatas formantibus. Sporae (?) . . . Sterile sed arc olis pyramidatis insigne” (Kalchbrenner l.c.).

*South African record* : on the ground, Natal, *Medley Wood* 375, 10704.

Medley Wood's collection is apparently the only record of this species; it is not a *Scleroderma*, but a gill fungus, thought to be *Montagnites*; as it is quite immature no more exact identification can be made.

**Scleroderma stellenbossiensis** Verwoerd.

South African Journal of Science 23 (1926) 292.

*Peridium* 0·2-5·0 cm. diam., epigeous, more or less globose, with an irregular stem-like base 1-4 cm. long, single, rather thick, smooth, dingy with a purplish tinge when fresh, dehiscing by splitting into four irregular segments. *Gleba* white, later purplish. Spores globose, 7·2-10·8  $\mu$ , strongly echinulate, brown. (Description ex Verwoerd, l.c.)

*Habitat* : on damp clayey ground.

*Distribution* : South Africa.

South African Record : Stellenbosch, C.P., L. Verwoerd 300 (Stell. 2223).

A hurried examination of specimens of the above collection suggested that the species is very close to *S. verrucosum*. The only difference appears to be the smooth instead of rough peridium. It may be the same as Dr. Duthie's specimen No. 118, also collected at Stellenbosch, which Lloyd called *S. laeve*, remarking that, in his opinion, it was a smooth form of *S. verrucosum*. A further, more critical examination of Verwoerd's specimens is necessary before any further comment can be made.

**Scleroderma tenerum** Berkeley.

in Cooke, Cuban Fungi, No. 512.

Specimens not seen : along edge of stream, Belvidere, Knysna, *Duthie 141*; inside decayed tree, Stellenbosch, *Duthie 119*.

Five collections of this species have been recorded for South Africa. Of these *Duthie 212* and *Duthie 278*, 31451, collected at Knysna, are considered to be a form of *S. verrucosum*; the other two Duthie collections have not been seen. Judging from the spores, not mentioned in the original description of *S. tenerum*, v. d. *Byl 619* appears to be something different. The spores are smooth or obscurely verrucose, pale ochraceous and the average size 4  $\mu$  diam. Other characters are : *Peridium* 1·2-1·4 cm. wide, 0·8-1 cm. high, ochraceous, cracking into small, closely set, flattened verrucae, prolonged into a thick, acuminate rooting structure. *Gleba* ochraceous. The van der Byl specimen should be more critically examined.

2. **PISOLITHUS** Albertini et Schweinitz.

Conspectus fungorum in Lusatiae Superiores (1805) 82.

G. H. Cunningham, Gastero. (1944) 121; Verwoerd, Ann. Univ. Stell. 3 (1925) 16.

Ed. Fischer in Nat. Pflanz. 7a (1933) 39.

*Polysaccum* DC et Desp., Rapp. voy. bot. l'Ouest Fr. 1 (1807) 8.

*Pisocarpium* Link, Mag. Ges. nat. Freunde 3 (1809) 33.

*Durosaccum* Lloyd, Myc. Writ. 7 (1924) 1306.

Type Species : *Pisolithus tinctorius* (Mich. ex Pers.) Coker & Couch.

Plants consisting of a peridium supported on a well developed rooting base. Peridial wall of one layer only, which is thin, membranous and brittle. Dehiscence by the breaking into segments of the upper part of the peridial wall, exposing the finally pulverulent gleba. Gleba divided into subglobose or polygonal spore-bearing cavities—the peridioles—which are separated by persistent walls—the trama plates—on which the basidia and spores are borne. Capillitium absent. Spores globose, echinulate, coloured. Basidia pyriform, bearing 2-6 spores on short sterigmata.

The characteristic features of this genus are the 1-layered peridial wall, the division of the gleba into cavities separated by persistent walls and the absence of capillitium threads. It differs from *Scleroderma* in having persistent trama plates.

Owing to the great variation shown by this plant, numerous different species have been described for it, but it is considered by Cunningham and others that there are at most three good species, viz. *P. tinctorius*, *P. microcarpus* and *P. Boudieri*. Of these only *P. tinctorius* is known to occur in South Africa. *P. microcarpus* is found in Australia and *P. Boudieri*, if distinct from the first named, is found in Corsica.

**Pisolithus tinctorius** (Micheli ex Persoon) Coker & Couch. [Plate XXXII, fig. 1, 2.]

Gasteromycetes of the Eastern United States and Canada (1928) 170.

G. H. Cunningham, Gastero. (1944) 122.

*Scleroderma tinctorium* (Mich.) Pers., Syn. Meth. Fung. (1801) 152.

*Pisolithus arenarius* Alb. & Schw., Conspectus (1805) 82.

*Polysaccum crassipes* DC. & Despr., Rapp. bot. Fr. 1 (1807) 82; Sacc. Syll. Fung. 7 (1888) 146; van der Byl, Trans. Roy. Soc. S. Afr. 6 (1918) 209; Verwoerd, Ann. Univ. Stell. 3 (1925) 16.

*P. acaule* DC., Fl. Fr. 5 (1815) 103.

*Pisocarpium clavatum* Nees, Syst. Pilze (1817) 138.

*Polysaccum herculeum* (Pers.) Fr., Syst. Myc. 3 (1829) 52.

*P. turgidum* Fr., l.c., p. 53.

*P. olivaceum* Fr., l.c., p. 54.

*P. pisocarpium* Fr., l.c.

*P. tuberosum* (Mich.) Fr., l.c., p. 55.

*P. comglomeratum* Fr., l.c.

*P. arenarium* (Alb. & Schw.) Corda, Icon. Fung. 2 (1838) 24.

*P. tinctorium* Mont., Phyto. Canariensis (1840) 87.

*P. australe* Lév., Ann. Sci. Nat. Ser. 3, 9 (1848) 136.

*P. leptothecum* Reich., Reise Oesterr. Novara um d. Erde 1 (1879) 134.

*P. marmoratum* Berk., Journ. Linn. Soc. 13 (1972) 155.

*P. boreale* Karst., Not. Faun. et H. Fenn., 8 (1882) 203.

*Scleroderma umbrinum* Cooke & Mass., Grev. 19 (1890) 45.

*Polysaccum album* Cooke & Mass., Grev. 20 (1891) 36.

*P. pisocarpium* var. *novo-zelanica* P. Henn., in Engl. Bot. Jaeb. 18 (1894) 37.

*Pisolithus tinctorius* (Mont.) Fisch., Nat. Pflanz. 1 (1900) 338.

*P. australis* (Lév.) Fisch., l.c.

*Polysaccum pusillum* Pat. & Har., Journ. de Bot. 17 (1903) 13.

*P. umbrinum* (Cooke & Mass.) Lloyd, Myc. Writ. 1, Lyc. Aus. (1905) 13.

*Pisolithus Kisslingi* Fisch., Mitt. Nat. Ges. Bern. 10 (1906) 10.

*Polysaccum pygmaeum* Lloyd, Myc. Writ. 7 (1924) 1306.

Plants up to 20 cm. tall, 17 cm. broad, solid and firm when young, variable in shape — subglobose, pulvinate, broadly oval, pyriform, mature specimens often irregularly lobed due to the splitting of the peridium when maturing, usually narrowing gradually, or often suddenly into a stout, often irregular rooting base, which is attached to the substratum by

yellowish rhizomorphic strands. *Peridium* 1-layered, thin, brittle, finally cracking in the upper part into segments, which fall away, exposing the disintegrating, finally pulverulent gleba, smooth or occasionally rugulose, shining, ochraceous to bright yellow at first, especially towards the base, becoming greyish brown to blackish or grey with brown (Vandyke brown) markings, producing a snake skin effect. Rooting base yellow to yellowish or dark brown, at first of an indiarubber-like texture within, later hard and woody. *Gleba* divided into subspherical, broadly oval or irregular polygonal cavities—the peridioles—1–4 mm. long, 1–2 mm. wide, separated by persistent walls—the tramal plates—which are thick, black, wet and of indiarubber texture at first, but finally become dry and pulverulent and olivaceous brown or umber in colour. In the young plant, the whitish spore-filled peridioles, with their dark partitions, produce a characteristic mottled effect. *Capillitium* threads wanting. Spores globose, strongly echinulate, 5–8.5  $\mu$  diam., borne on the tramal plates lining the cavities, olivaceous brown.

*Habitat* : in sandy, gravelly or hard, stony soil; solitary or caespitose, usually under, or in the vicinity of *Eucalyptus* trees.

*Distribution* : South Africa; North America; Australia; East Indies; New Zealand; Tasmania.

*Specimens examined* : Under *Eucalyptus* spp., Pretoria, May 1911, *I. B. Pole Evans*, 1560; Eloff's Cutting, Pretoria, *O. Weeber*, Sept. 1909, 959, Sept. 1911, 886; Zoo Cutting, Pretoria, *A. O. D. Mogg*, 23638; Meintjes Kop, Pretoria, May 1923, *S. Goyer*, 17093; Pretoria-Johannesburg road, Sept. 1925, *K. Vos*, 20627, April 1939, *A. O. D. Mogg*, 30781; Groenkloof, Pretoria, April 1915, *J. Sellschop*, 8958; Buccleuch, Natal, Nov. 1916, *J. M. Sim*, 9792; Donnybrook, Natal, Feb. 1935, *K. E. Morgan*, 28950; Lobatsi, Bechuanaland, May 1923, *Wallace*, 17094; Trappe's Valley, Bathurst Distr., Sept. 1930, *R. A. Dyer*, 25495; Klapmuts, C.P., June 1929, *Dr. André*, 24842; Newlands, C.P., April, *A. V. Duthie* 123, 31358; Deepwalls, Knysna, Oct. 1923, *J. Phillips* (v. d. Byl 2325) 18040, Transvaal, Feb. 1919, *L. Kretzschmar*, 11815; Maritzburg, Natal, *W. G. Rump* (v. d. Byl 2623); Pretoria, v. d. Byl 1965; Tzaneen, Tvl., July 1924, v. d. Byl 1474; Stellenbosch, v. d. Byl (Stell. 157); Elgin, C.P., *E. L. Stephens* 419; Somerset West, April 1940, *S. Garside* (E. L. Stephens 508). Numerous other collections have been recorded from both the Cape and Transvaal Provinces.

*Specimens not seen* : Grahamstown, *N. J. G. Smith*, Kew; nr. Solheim M.S., Eshowe, *Hpeg 170*; Potchefstroom, *Radloff* (v. d. Byl 2092).

The distinguishing features of this plant are the single layered peridial wall, the division of the gleba into cavities separated by permanent walls and the absence of capillitium threads.

This plant is commonly known in South Africa as *Polysaceum crassipes*, but, in accordance with the International Rules of Botanical Nomenclature, this name must give way to the earlier one of *Pisolithus tinctorius*. It is widely distributed throughout the country and very common some seasons; as far as our experience goes, it is usually, if not always found in association with *Eucalyptus* trees, on the roots of which rhizomorphic strands of the fungus may form yellowish masses. Van der Byl (l.c.) who investigated the relationship between *Eucalyptus* trees and the fungus, came to the conclusion that it was one of symbiosis. Miss E. L. Stephens of Cape Town University records the occurrence of this fungus in the Cape Peninsula under Myrtaceous hedges. In this connection, van der Byl (l.c.) mentions that Bruns found *Polysaccum* forming coatings on the roots of pines, but no other reference to a possible symbiotic relationship between this fungus and any other plant has been noted.

As the specific name suggests, *Pisolithus tinctorius* contains a bright olivaceous yellow dye, which permanently stains cotton and woollen goods and paper.

## ARACHNIACEAE Coker &amp; Couch.

Gasteromycetes of the Eastern United States and Canada (1928) 144; Verwoerd, Ann. Univ. Stell. 3 (1925) 19.

Plants epigeous, subglobose, sessile. Peridium 1-layered, very thin, fragile, disintegrating at maturity. Gleba consisting of distinct chambers or peridioles, which finally crumble and form a mass of minute, separable, hollow bodies resembling grains of sand; peridioles lined with a hymenial layer on which the spores are borne. Capillitium lacking. Spores small, globose or subglobose, smooth, pedicellate or not.

This family contains but one well defined genus, namely *Arachnion*, which consists of small, delicate plants resembling small Lycoperdons without the apical stoma. The systematic position of the family is uncertain and has given rise to conflicting opinions. According to Coker and Couch (l.c.) it is most nearly related to the Lycoperdaceae, but differs in having a 1-layered peridium, in the absence of capillitium threads and presence of peridioles; they do not, however, suggest where they consider it should be placed. Fischer (Nat. Pflanzen. 7a, 1933: 55) places it in the Nidulariineae on account of the presence of peridioles, Verwoerd (l.c.) places it in the Sclerodermataceae. Cunningham expresses no opinion on the matter, presumably because the family is not represented in the areas worked by him. However, following Cunningham's interpretation of the various families, as expressed in his general classification, the Arachniaceae seems to fit best in the order Sclerodermatales, since the gleba becomes pulverulent at maturity and lacks capillitium threads, the two characters on which this order is separated from other orders. This arrangement has therefore been followed.

## ARACHNION Schweinitz. p. 505

Synopsis Fungorum Carolinae superioris, Naturforschenden Gesellschaft 1 (1920) 20.

*Scoleciocarpus* Berk., Enum. Fung. coll. Herr Zeyher in Hooker's London Journ. Bot. 2 (1843) 420.

Type species: *Arachnion album* Schw.

Plants superficial, subglobose, with basal mycelial threads. Peridium thin, fragile, breaking up at maturity. Gleba consisting of numerous, closely compacted, globose or elliptical chambers, lined with a hymenial layer on the basidia of which the spores are borne. At maturity the chambers form a mass of minute, separable, hollow peridioles, which crumble and resemble grains of sand. Capillitium and sterile base lacking, Basidia 4-spored. Spores long pedicellate, smooth, globose or shortly elliptical.

This genus is characterised by its simple peridial wall, the absence of capillitium and the presence of peridioles lined with a hymenial layer.

## Key to the Species.

Peridial wall smooth.

Spores pedicellate.

Plants 1-2.2 cm. diam., white, silver grey, buff. Gleba grey to greenish olive.....

1. *A. album*.

Plants 1.5-3 cm., originally pinkish. Gleba purplish, then greyish white.....

2. *A. alborosella*.

Plants 5-7 cm. diam., dark sooty coloured. Gleba ash grey.....

3. *A. giganteum*.

Spores not pedicellate.

Plants 1-3.5 cm. diam., white then grey. Gleba ash-coloured.....

4. *A. firmoderma*.

Peridial wall finely warted.

Spores pedicellate.

Plants 1-1.5 cm. diam., pale yellowish. Gleba greenish olive.....

5. *A. scleroderma*.

1. **Arachnion album** Schweinitz. [Plate XXXI, fig. 1.]

Synopsis Fungorum Carolinae superioris, Naturforschenden Gesellschaft 1 (1820) 20  
Verwoerd, Ann. Univ. Stell. 3 (1925) 19; Coker & Couch, Gastero. (1928) 145.

*Scoleciocarpus tener* Berk., Hooker's Journ. Bot. (1843) 520.

*S. bovista* Mont., Ann. Sci. Nat. 3 sér. 11 (1849) 33.

*Arachnion bovi ta* Mont., l.c. 12 (1849) 302.

*A. Drummondii* Berk., Journ. Linn. Soc. 18 (1881) 389.

Plants superficial, subglobose, sessile, attached by a single rooting structure, 1-2.2 cm diam. *Peridium* white, silver grey or pale buff coloured, smooth, becoming wrinkled when dry, thin, fragile, breaking up when mature. *Gleba* white then grey, finally brownish-olive (nearest Deep Greyish Olive) composed of numerous empty chambers lined with a hymenial layer "apparently made up only of basidia, the context between the chambers consisting of a loose weft of delicate, interwoven hyphae. At maturity, this loose tissue breaks down and leaves the chambers as distinct granular particles, which contain the spores and fall apart like sand at maturity or decay into a sordid mass in wet weather" (words in inverted commas ex Coker & Couch l.c.). *Spores* globose or subglobose, smooth, tinted brown, 3.6-4.5  $\mu$  diam., long pedicellate; pedicels thin, hyaline, up to 50.4  $\mu$  long, average size 18.0-25  $\mu$ .

*Habitat*: in open grassy places, under trees, in flower garden beds.

*Distribution*: South and East Africa; North and South America; Europe.

*Specimens examined*: Stellenbosch Flats, C.P., May and June, *Duthie* 21, 31303; Stellenbosch, June 1921, *Duthie* (E. L. Stephens 82a) 31506, 31507; Belvidere, Knysna, C.P., Dec. 1920, *Duthie* 68, 31330, Jan. 1919, *Duthie* 217, 31405; July 1919, *Duthie* 240, 31423; Forest Hall, Knysna, Feb. 1919, *Duthie* 219, 31407, *Duthie* 220, 31408; Feb. 1919, *Duthie* 222, 31410; Stellenbosch, *L. Verwoerd* (Stell. 172; v. d. Byl 1968); Mowbray, C.P., *M. Levyns* (v. d. Byl 2109); Pasture Research Station, Rietvlei, Pretoria, March 1945, *A. M. Bottomley*, 35432; Kalberg, C.P., Jan. 1939, *E. L. Stephens* 429.

*Specimen not seen*: locality unknown, *E. L. Stephens* 320, 398.

This species is recognised by its smooth, whitish peridium.

2. **Arachnion alborosella** Verwoerd.

South African Journal of Science 23 (1926) 291.

Plants 1.5-3.0 cm. diam., superficial, sessile, more or less globose, attached by a rooting strand. *Peridium* smooth, white, tinted with pink, which fades or altogether disappears from herbarium specimens, very thin, papery. *Gleba* purplish, becoming greyish white, consisting of small peridioles, irregular in shape and size and mixed with fungus tissue. *Spores* globose, 3.6-4.5  $\mu$  diam., very faintly tinted, smooth, pedicellate; pedicel rather thin and long.

*Habitat*: in veld.

*Distribution*: South Africa.

*South African specimens*: Brandfort, O.F.S., *L. Verwoerd* T234 (v. d. Byl 2221).

This species is characterised by the originally pink colour of the peridial wall. No specimens were available for examination.

3. **Arachnion giganteum** Lloyd.

Mycological Writings 5, Mycological Notes 46 (1917) 645.

Plants 5-7 cm. diam., globose, attached by a few mycelial threads. *Peridium* thin, fragile, smooth, dark fuliginous. *Gleba* resembling grains of sand, ash grey. *Peridioles* globose or oblong, rather firm, 200-400  $\mu$  diam. *Spores* globose, 8.0  $\mu$  diam., smooth, tinted without a pedicel.

*Habitat* : on ground.

*Distribution* : South Africa.

*South African Specimens* : Clanwilliam, *Duthie* 166a (Lloyd Myc. Coll. 22753); Stellenbosch, *Duthie* 255 (Lloyd Myc. Coll. 50745); Belvidere, Knysna, *Duthie* 254.

This species is recognised by its large size and the absence of a spore pedicel. It was described by Lloyd from a specimen supplied by Dr. Duthie. Unfortunately no duplicate material was lodged in any herbarium in South Africa.

#### 4. *Arachnion firmoderma* Verwoerd.

*South African Journal of Science* 23 (1926) 290.

Plants 1-3.5 cm. diam., superficial, sessile, more or less globose, sometimes broadly oval, with a thin rooting strand. *Peridium* smooth, white then grey, rather thick, firm, leathery, breaking up irregularly. *Gleba* ochraceous or ash coloured, consisting of small peridioles up to 1.5 mm. long diam. mixed with fungus tissue. *Spores* globose, 4.5-6.3  $\mu$  diam., thick-walled, smooth, hyaline to tinted, often apiculate.

*Habitat* : on ground frequented by cattle.

*Distribution* : South Africa.

*South African Specimens* : Brandfort, O.F.S., *L. Verwoerd* 233 (v. d. Byl 2220).

This species is said to differ from *A. album* in size, in the white, thicker and more permanent peridium and in the absence of spore pedicels. The material was not available for examination.

#### 5. *Arachnion scleroderma* Lloyd.

*Mycological Writings* 4, *Mycological Notes* 39 (1915) 538.

*Myc. Writ.* 5, *Myc. Notes* 46 (1917) 644; *Verwoerd*, *Ann. Univ. Stell.* 3 (1925) 20

Plants 1-2 cm. diam., globose, subglobose, with a strong rooting base. *Peridium* thin, pale yellowish to ochraceous, smooth, clothed with small, irregular, closely set, caducous warts. *Gleba* olivaceous-grey, grey. *Peridioles* irregular both in size and shape, from globose to narrowly elongated or obtusely triangular, 60-300  $\mu$  diam. *Spores* globose or somewhat egg-shaped, smooth, subhyaline to pale olivaceous-brown, 3.4-4  $\mu$  diam., pedicellate or no; pedicels, when present, 5-20  $\mu$  long.

*Habitat* : in open places.

*Distribution* : South Africa.

*Specimens examined* : Flats, Stellenbosch, May, *Duthie* 41 (E. L. Stephens 82 A & B; 31313; *Duthie* 70 (van der Byl 1969; Lloyd, Myc. Coll. 22677, 22678) 31501; Johannesburg, Feb. 1946, *C. Cohen*.

*Specimens not seen* : Flats, Stellenbosch, *Duthie* 232 (Lloyd Myc. Coll. 24892) Stellenbosch, *Verwoerd* (Stell. 183); locality unknown, *E. L. Stephens* 217.

This species is recognised by its warty peridial wall.

## LYCOPERDALES.

Peridium finally superficial, originally attached to a substratum by mycelial threads, globose or variously shaped, sessile or stipitate, of one, two or more layers, dehiscing by an apical pore (occasionally several) or by the gradual breaking down of the upper portion or by circumscissile splitting of the endoperidium. Gleba pulverulent at maturity, consisting of numerous, simple or branched, hyaline or coloured capillitium threads. Spores hyaline or coloured, rough or smooth, globose, elliptical or occasionally irregular. Basidia 1-8-spored, cylindrical or clavate.

This is the largest order of the Gasteromycetes, including all those groups of fungi referred to in general as "Puff Balls". It is distinguished from other orders on the nature of the gleba, which consists of well-developed capillitium threads mixed with the spores and which becomes pulverulent at maturity.

The order is divided into two well-defined families—*Lycoperdaceae* and *Tulostomataceae*—separated from each other on the stem character. The former is either sessile or has only a stem-like base, while the latter has a true, well-developed stem.

## LYCOPERDACEAE Corda.

Icones Fungorum 5 (1842) 22; emended G. H. Cunningham, Proceedings of the Linnean Society of New South Wales 57 (1932) 315.

G. H. Cunningham, Gastero. (1944) 124.

*Peridium* usually globose or subglobose, at least when young; attached to the substratum by mycelial threads, sessile or with a stem-like base of sterile tissue; wall consisting of one to four layers, dehiscing by a pore (occasionally several) or by the breaking away of the apical portion. *Capillitium* threads abundant, simple or freely branched, hyaline or coloured, varying in thickness. Spores globose or elliptical, usually roughened, but sometimes smooth. *Basidia* 1-8-spored, spores on sterigmata.

The *Lycoperdaceae* contains the true "Puff Balls" so called on account of the shape of the plants, which is typically ball-like—at least in the early stages—and the fact that the spores are ejected from the plant through the apical pore in puffs. *Lycoperdon*, which is the representative genus of the family and contains the largest number of species, is the typical puff ball plant.

Cunningham divides the *Lycoperdaceae* into three sections, or tribes as he calls them—*Mesophelliae*, *Lycoperdeae* and *Geastreac*—according to the number of layers in the peridial wall, the manner of dehiscence and the nature of the spores. In the *Mesophelliae* he places the genera *Mesophellia*, *Castoreum* and *Abstoma*; these genera are characterised by a three-layered peridial wall, the outer two layers of which form a brittle shell, unbranched capillitium threads, spores with a gelatinous exospore and dehiscence by disintegration of the whole plant. None of these three genera is known to occur in South Africa, and the *Mesophelliae* section is therefore excluded from the present work.

## Key to the Genera.

A.—**Mesophelliae**.—c.f. general key for characteristics.

B.—**Lycoperdeae**.—Peridium 1-2-layered, dehiscing by an apical pore or by irregular rupture of the apex. Capillitium threads simple or freely branched. Spores typically globose and verrucose. Plants usually few, single or caespitose.

Capillitium threads without spines. Inner peridium membranous, thin, firm, or soon breaking up, seldom rigid and permanent.

Capillitium threads more or less smooth, without a thick main stem and thinner, short, pointed branches.

Plants dehiscing by an apical pore.

Capillitium threads attached to the endoperidial wall, long, simple or sparingly branched.....

Capillitium threads free within the peridium, short, simple or branched.....

Plants dehiscing by rupture or disintegration of the apex.

Capillitium pulverulent or compact. Sterile base usually present. Endoperidium usually thick, tough.....

Capillitium compact. Sterile base lacking. Endoperidium thin, papery, brittle. Plants becoming detached at maturity.....

Capillitium threads freely branched, consisting of a thick stem with sharp pointed, tapering, thinner branches....

Capillitium threads spiny, short, free within the endoperidium. Endoperidial wall thick and corky.....

Plants numerous, borne on a common stroma, whole cluster covered by a universal exoperidium.

Peridia separated from each other by alveolar walls.....

Each peridium provided with an individual exoperidium, the cup-like remains of which separate the peridia from each other.....

C.—**Geastreae.**—Peridium 4-layered. Exoperidium splits into segments in stellate manner. Endoperidium dehisses by one or more pores or by rupture of the apex. Capillitium threads simple or branched. Spores typically globose and verrucose or echinulate.

Plants dehiscing by a single apical pore.....

Plants dehiscing by several apical pores.....

Plants dehiscing by rupture of the endoperidium from apex downwards..

1. **Lycoperdon.**

2. **Disciseda.**

3. **Calvatia.**

4. **Lanopila.**

5. **Bovista.**

6. **Mycenastrum.**

7. **Broomeia.**

(*Diplocystis*).

8. **Geastrum.**

9. **Myriostoma.**

10. **Geasteropsis.**

### Lycoperdeae.

Peridium usually of two layers, the outer or exoperidium often reduced to granules, warts or spines, which, at maturity, frequently fall away to a greater or less extent. Dehiscence by an apical pore or by irregular breaking away of the apical portion. Gleba consisting of simple or branched, long or short, smooth, or in one case (*Mycenastrum*) spiny threads. Sterile base and diaphragm present or absent. Spores globose, typically roughened but occasionally smooth.

In South Africa seven genera are recognised as belonging to the Lycoperdeae—*Lycoperdon*, *Disciseda*, *Bovista*, *Calvatia*, *Lanopila*, *Mycenastrum* and *Broomeia*. Of these *Lycoperdon* is the best known, containing the largest number of species distributed over the world, of any member of the Gasteromycetes.

#### 1. LYCOPERDON Tournefort ex Persoon.

Synopsis Methodica Fungorum (1801) 138.

Type Species : *Lycoperdon perlatum* Pers.

Plants globose, subglobose or pyriform, attached to the substratum by means of basal, root-like threads. Peridium of two layers—a usually fugacious, roughened exoperidium and a thin, membranaceous, persistent endoperidium—the latter dehiscing by means of an apical aperture. A sterile base, with or without a diaphragm, may or may not be present. Gleba finally pulverulent, consisting of capillitium and spores. Capillitium threads long, simple or branched, septate or not, coloured or hyaline, usually varying in thickness. Spores coloured, globose or oval, smooth, verrucose or echinulate, pedicellate or not.

To this genus belong the true "puff balls" or "monkey snuff-boxes" as they are sometimes locally termed, so-called on account of their ball-like shape and the fact that the spores are ejected from an aperture in the apex of the mature plant in clouds or puffs. Most Lycoperdons are white or yellowish when young, but change to some shade of grey or brown with maturity. The plants are comparatively small in size and grow on the ground in open or shaded places, or occasionally on decayed wood. All species are said to be harmless, provided they are eaten young, when the flesh is still white and solid.

It is difficult to say how many clearly defined species of *Lycoperdon* occur in South Africa. About 39 different species have been described from time to time, but many of these are synonymous with species occurring elsewhere, while a few have been transferred to the genus *Calvatia*. For these reasons about 19 names have been excluded from the present paper. There are also about eight of the old species of which no material is available for examination and of which the published descriptions are too inadequate for recognition of the plants. These have been included in a section by themselves at the end of the classified species. Only 17 species are recognised as specifically distinct and of these two are considered to be so far underscribed.

#### Key to the Species.

Spores not pedicellate.

Capillitium hyaline.

Sterile base well developed, cellular.

Diaphragm present.

Gleba yellow, brown or olive.....

Gleba some shade of purple.....

Sterile base small, compact.....

1. *L. hyemale*.

2. *L. djurens*e.

3. *L. subincarnatum*.

Capillitium coloured.

Capillitium not or sparingly branched.

Sterile base of large cells, 2 mm. or more diameter.

Diaphragm present.....

4. *L. rhodesianum*.

Diaphragm absent.

Exoperidium of conspicuous, pointed verrucae.....

5. *L. perlatum*.

(*L. pyriforme*).

Exoperidium of minute, connivent spines.....

Sterile base of small cells, 1 mm. or less diameter.

Diaphragm absent.

Exoperidium of connivent spines and warts.....

6. *L. Duthiei*.

Exoperidium furfuraceous.....

7. *L. caffrorum*.

Sterile base absent.

Exoperidium white, verrucose or furfuraceous.....

8. *L. caespitosum*.

Exoperidium ochraceous yellow, smooth.....

9. *L. flavum*.

Capillitium freely branched.

Sterile base cellular.....

(*L. spadiceum*).

Sterile base compact.....

10. *L. polymorphum*.

Sterile base absent.....

11. *L. pusillum*.

Spores long pedicellate; pedicels persistent.

Sterile base well developed, cellular.

Diaphragm present.

Exoperidium of dark, furfuraceous verrucae.....

12. *L. Quedenii*.

Diaphragm absent.

Exoperidium of dark verrucae.....

13. *L. umbrinum*.

Sterile base scanty, minutely cellular, no diaphragm.

Exoperidium of pallid cruciate spines.....

14. *L. asperum*.

Sterile base absent.

Exoperidium verrucose, gleba yellowish.....

15. *L. Gunnii*.

1. *Lycoperdon hyemale* (Bulliard ex Persoon) Vittadini. [Plate XXXIII, fig. 1, 2, 3 ;  
Plate XXXIV.]

Bulliard, Histoires Champignons de la France 1 (1809) 148 ; emended Vittadini, Monographia Lycoperdineorum (1842) 46.

Hollós, Gastero. (1904) ; Massee, Journ. Roy. Micro. Soc. (1887) 712 ; Sacc. Syll. Fung. 7 (1888) 115, 480 ; G. H. Cunningham, Gastero. (1944) 146.

*Lycoperdon depresso* Bonorden, Bot. Zeit. (1857) 611 ; Massee, Trans. Roy. Micro. Soc. (1887) 714 ; Trans. Brit. Myc. Soc. 2 (1906) 98.

*L. natalense* Cooke et Massee, Journ. Roy. Micro. Soc. (1887) 709 ; Sacc. Syll. Fung. 7 (1888) 478.

*L. Kalchbrenneri* de Toni, Sacc. Syll. Fung. 7 (1888) 109.

*L. pratense* Pers., Trans. Brit. Myc. Soc. 2 (1906) 160.

*L. Curtissii* Berk., Grev. 2 (1873) 50.

*L. multiseptum* Lloyd, Myc. Writ. 4, L. 53 (1914) 9.

*L. Eylesii* Verwoerd, S. Afr. Journ. Sci. 23 (1926) 292, 294.

*Peridium* 0.5-5 cm. diam., subglobose, obovate, or sometimes pyriform, narrowing suddenly or gradually towards a furrowed, plicate or lacunose rooting base, sometimes slightly umbonate at the top ; pure white or white with a tinge of yellow at the base, finally discoloured. *Exoperidium* white then ochraceous, covered with small, white pyramidal warts or connivent spines often mixed with granules, usually fugacious in part or the whole of the upper part, but persistent in the basal area ; sometimes furfuraceous at the base, spinulose in the centre and warty at the apex, the whole finally almost smooth. *Endoperidium* deep cream, buff, ochraceous, finally cinereous or parchment coloured, more or less smooth, often with areoles left by the bases of the fallen warts, or obscurely granular or furfuraceous ; dehiscing by a torn, small or large, round or elliptical, apical pore, the surrounding portion of which often finally breaks away, leaving a large, irregular aperture. *Gleba* pulverulent, varying in colour between yellowish, yellowish-olivaceous, liliaceous grey, light grey, slate grey, brown, olivaceous and reddish brown. *Sterile base* present, occupying from one-quarter to one-half of the total height, cellular, cells usually large ; white, becoming ochraceous. *Diaphragm* well defined, straight, convex or concave. *Capillitium* threads scanty in old specimens, usually long, hyaline or tinted olivaceous, usually many septate, sparingly branched, usually thicker than diameter of spores (up to 10.2  $\mu$  or more), smooth to granular. *Spores* globose, pale olivaceous-brown, 3.5-4.2  $\mu$  diam., almost smooth to coarsely verrucose, sometimes found in semi-permanent, oblong, smut-like balls ; sometimes apiculate or shortly pedicellate ; pedicels usually fugacious.

*Habitat* : on the ground amongst grass, solitary, caespitose or in groups. A very common species.

*Distribution* : South Africa ; Australia ; Britain ; Europe ; New Zealand ; Tasmania.

*Specimens examined* : Pretoria, Dec. 1909, *E. M. Doidge*, 958 ; Jan. 1919, *A. M. Bottomley*, 11864, 11866 ; Feb. 1939, *A. M. Bottomley*, 33462, 33772 (spores pedicellate) ; Dec. 1938, *A. M. Bottomley*, 35530 ; Jan. 1919, *C. P. Lounsbury*, 11867 ; April 1924, *E. M. Doidge*, 21583 ; Groenkloof, Pretoria, *I. B. Pole Evans*, 8780 ; Aug. 1916, *J. Sellschop*, 9775 ; March 1924, *K. A. Lansdell*, 18144 ; Kilmerton, Pretoria, March 1912, *P. J. Pienaar*, 2242 ; Garstfontein, Pretoria, Feb. 1911, 18089 ; March 1911, *P. J. Pienaar*, 1876 ; Fairy Glen, Pretoria, Feb. 1928, *A. M. Bottomley*, 23169 ; Brenton, Knysna, *A. V. Duthie*, 31347 ; Belvidere, Knysna, *A. V. Duthie*, 31348 as *L. pratense* ; Johannesburg, *E. M. Doidge*, 27804 ; Rondebosch, Feb. 1937, *E. L. Stephens* 450, 34534 ; Brandfort, O.F.S., *L. Verwoerd*, 34535 ; O.F.S., Jan. 1937, *Miss Olivier*, 34557 ; Pietermaritzburg, *Rump* 389, 30798 ; Van Reenen, Natal, Dec. 1912, *M. Franks*, 5666 ; Mbabane, Swaziland, March 1911,

*T. A. Stewart*, 1557; *Kirstenbosch*, C.P., *S. Garabedian*, as *L. gemmatum* (S.A.M. 45896); *Knysna A. V. Duthie* as *L. pratense* (v. d. Byl 2034); *Cape, R. S. Adamson* (E. L. Stephens 447) 35533; *Salisbury, S. Rhodesia*, *F. Eyles* 4089 (v. d. Byl 2223) as *L. Eylesii* (specimens differ from typical *L. hyemale* only in very small size); *Beatrice, S. Rhodesia*, April 1926, *Eyls* 4090 (S.R. 3823); *Boschberg Mts., Somerset East*, *MacOwan* 1003 as *L. gemmatum* (sub *L. caffrorum* Kalchbr. & Cooke in *Fungi MacOwanianae*) (S.A.M. 35051) 22060.

*Specimens not seen*: *Knysna, Duthie* 38, 256 (Lloyd, Myc. Coll. 53127, type of *L. multiseptum*, 51764; *Inanda, Natal, Medley Wood* 358, 361, as *L. natalense* Cooke & Mass. in Herb. Kew; *Natal, Medley Wood* 185 as *L. Curtisi* Berk.; *Somerset East, MacOwan*, as *L. Curtisi*; *slope of Katberg, Jan. 1939, E. L. Stephens* 428.

The distinguishing features of this species are the apical connivent spines of the exoperidium, the hyaline to tinted, septate capillitium threads, the usually well developed, cellular sterile base and the presence of a well defined diaphragm. It is a very variable plant as regards size, colour of the gleba and size and shape of the sterile base. The colour of the gleba may vary even in plants of one collection, therefore, with one exception (cf. *L. djurens*) it has not been possible to separate species on the colour of the gleba. The size of the sterile base varies according to the shape of the plant—small in subglobose plants and large in subpyriform.

This is the commonest species in South Africa, usually occurring in grassy places. It is a frequent cause of "Fairy Rings" in bowling and golf greens.

Hollós (l.c.) has been followed in including *L. depressum*, *L. Kalchbrenneri*, *L. marginatum* and *L. Curtisi* as synonyms of *L. hyemale*, Cunningham (l.c.) in including *L. natalense* and Lloyd in including *L. pratense*. Descriptions of these species do not indicate any important point of difference from the South African plant.

## 2. *Lycoperdon djurens* P. Hennings.

[Plate XXXV, fig. 2.]

*Hedwigia* (1901) 100.

Lloyd, Myc. Writ. 5, L. 66 (1917) 16; Verwoerd, Ann. Univ. Stell. 3 (1925) 32.

? *L. endotephrum* Pat., Bull. Soc. Myc. Fr. (1902) 300; Sacc. Syll. Fung. 17 (1905) 231.

*Peridium* 1.5–4.5 cm. wide, 1–2.3 cm. high, subglobose, pulvinate or obconic, usually sulcate or lacunose towards the base, attached by mycelial threads. Young plant pure white or yellowish towards the base, becoming discoloured a pale brownish or greyish colour. *Exoperidium*, upper part covered with white, pyramidal warts, which consist of groups of broad spines the tips of which connive. These become progressively smaller towards the base finally consisting of mealy particles; usually fugacious in the upper part, especially in wet weather, and more or less persistent in the basal half. On a hot day following rain, the exoperidium may split irregularly from the apex downwards and break away in patches, exposing the endoperidium. *Endoperidium* white, becoming parchment coloured or pale grey when old, or occasionally purplish slate grey due to the presence of liberated spores, smooth, obscurely furfuraceous or finely reticulated in the upper part, opening by an irregular round or elliptical pore, which may enlarge considerably with age. *Gleba* white, then Light Mouse Gray to Mauve Grey, later Deep Mouse Gray or occasionally Deep Grayish Olive or ochraceous grey, finally Purplish Gray or Dark Olive Gray. *Sterile base* present, cellular, white, finally ochraceous or pale brown, straight, concave or sometimes convex in the centre, occupying from one-quarter to one-half of the total height. The size of the sterile base varies according to the shape of the plant, being smaller in subglobose plants than in plants narrowed towards the base. *Diaphragm* present. *Capillitium* threads hyaline or tinted, even or sometimes nodulose and irregular, often granular, sparingly

branched, septate; of varying thickness up to twice the diameter of the spores, typically thicker than diameter of spores. *Spores* globose, violaceous, grey or olivaceous grey, verrucose (examined dry) average size 3-4  $\mu$ , often shortly pedicellate or apiculate.

*Habitat*: on ground, often amongst short grass, solitary or gregarious, or caespitose in small or large, closely packed clusters (up to 20 individuals).

*Distribution*: South Africa; Central Africa.

*Specimens examined*: Pretoria, 1919, *A. M. Bottomley*, 11865, March 1945, 34589; Rietfontein, Pretoria, *Venter*, 14487; Wonderboom, Pretoria, March 1917, *H. A. V. King*, 10050; Rietvlei, Pretoria Distr., March 1945, *J. P. H. Acocks*, 34574, *Bottomley*, 34577, Meintjeskop, Pretoria, March 1921, *A. M. Bottomley*, 14648; Garstfontein, Pretoria Distr., Jan. 1946, *A. M. Bottomley*, 35426; Johannesburg, March 1934, Mr. Barracough, 27385. Schroeders, Natal, 1917, *P. A. v. d. Byl* (N.H. 462) 31761; Stellenbosch, *Eyles* 6667 (S. Rh, 3906); Salisbury, S. Rhodesia, Feb. 1920, *F. Eyles* 2524, 14855. (*Duthie* 302, 31470; identified as *L. djurens* is not this species; it is possibly an immature *L. Gunnii*.)

I have followed Lloyd (l.c.) and Verwoerd (l.c.) in retaining *L. djurens* as a separate species, but it so much resembles *L. hyemale* in every particular except the colour of the gleba that it would probably be better treated as a colour form of the latter. The colour of the gleba is a very variable factor and specimens with a violaceous gleba may be found in a collection in which the gleba is typically olivaceous or olivaceous-brown. I have therefore limited the species to plants in which the gleba is some shade of purple in every stage of growth. Specimens in collections Nos. 34574 and 34577 are typically characteristic, not one specimen amongst hundreds showing any but a violaceous gleba from the youngest to the oldest plants.

It is not clear when a violaceous gleba first came to be associated with *L. djurens*, since in Henning's original description the colour of the gleba is given as pale brown ("gleba pallide umbrina"). Lloyd (l.c.) on what authority it is not known, makes the following remarks with regard to this species:—"This is the only *Lycoperdon* known to me with purple gleba and hyaline capillitium and it has only been collected in Africa. Henning named it *L. djurensis* in 1901 and Patouillard *L. endotephrum* in 1902. I think Massee had it as *L. natalense*".

Patouillard describes the gleba of *L. endotephrum* as dirty violet, but Massee does not mention the gleba of *L. natalense* at all and merely describes the spores as "olive with a tinge of Purple". *L. endotephrum* is therefore left tentatively as a synonym of *L. djurens*, but *L. natalense* is cited as a synonym of *L. hyemale*.

### 3. *Lycoperdon subincarnatum* Peck.

Annual Report of the New York State Museum of Natural History, Botany, 24th Rep. (1872) No. 82.

Sacc. Syll. Fung. 7 (1888) 131, 484; G. H. Cunningham, Gastero. (1944) 147.

*Lycoperdon tephrum* Berk. in Herb. ex Massee, Journ. Roy. Mic. Soc. (1887) 723.

*Peridium* 1.2-2.5 cm., usually globose, rarely depressed or obovate. *Exoperidium* of small pyramidal warts, fugacious except towards base, whitish or ochraceous-cinereous. *Endoperidium* reddish brown, greyish-ochraceous or parchment coloured, becoming smooth or faintly reticulate in upper portion, flaccid, opening by an apical pore. *Gleba* umber brown. *Sterile base* absent. *Capillitium* threads hyaline or tinted yellowish-green, fairly frequently septate, sparingly if at all branched, diameter the same or larger than that of spores. *Spores* yellowish green, finally olivaceous, finely verruculose, globose, 3-4.6  $\mu$  diam., many with short, deciduous pedicels.

*Habitat* : on fallen trees or amongst moss on dead wood ; caespitose to gregarious.

*Distribution* : South Africa ; North America ; Australia.

*Specimens examined* : Cathkin Peak, Loskop, Natal, Feb. 1943, H. Lawrence, 35337.

This species is stated by Cunningham to be characterised by the peculiar pitted nature of the upper part of the peridium, the hyaline, septate capillitium, the very scanty, compact sterile base (when present) and the unusual habitat, i.e. decaying wood.

4. **Lycoperdon rhodesianum** Verwoerd.

South African Journal of Science 25 (1928) 237.

*Peridium* 2 cm. high, 3 cm. wide, subglobose or basin-shaped, sessile. *Exoperidium* furfuraceous. *Endoperidium* brown, thin, smooth, dehiscing by an apparently small, irregular mouth. *Gleba* olivaceous, with a sterile base of large cells, separated from the fertile portion by a diaphragm. *Capillitium* threads brown, unbranched, uniform, non-septate,  $3\text{--}6 \mu$  diam. *Spores* globose, hyaline to tinted, smooth,  $3\text{--}6 \mu$  diam. (Description ex Verwoerd, l.c.).

*Habitat* : on ground.

*Distribution* : South Africa.

*South African Record* : Salisbury, S. Rhodesia, F. Eyles 4223 (v. d. Byl 2412).

Verwoerd (l.c.) considers that this species is nearly related to *L. hyemale*, from which it differs in the following characters :—endoperidium brown instead of light yellow ; mouth small instead of large and torn ; exoperidium furfuraceous instead of shortly spiny ; capillitium threads brown, unbranched, non-septate,  $3\text{--}6 \mu$  thick, instead of hyaline to tinted, branched, septate,  $6\text{--}8 \mu$  diameter, spores  $3\text{--}6 \mu$  instead of  $4\mu$  diameter.

5. **Lycoperdon perlatum** Persoon. [Plate XXXV, fig. 1.]

Synopsis Methodica Fungorum (1801) 148.

G. H. Cunningham, Gastero. (1944) 149.

*Lycoperdon gemmatum* Batsch, Elench. Fung. (1783) 147.

*L. excipuliforme* (Scop.) Vitt., Mon. Lyc. (1842) 193.

*L. montanum* Quel., Champ. Jura (1876) 444.

*L. colensoi* Cooke et Massee, Journ. Roy. Micr. Soc. (1887) 711.

*L. tasmanicum* Mass., Kew Bull. (1901) 158.

*L. excoriatum* Lloyd, Myc. Writ. 2, Notes 22 (1905) 229.

*L. macrogemma* Lloyd, Myc. Writ. 2, Notes 22 (1906) 265.

*Peridium* up to 4.5 cm. high, 3 cm. wide, subglobose, obovate, but usually turbinate or pyriform ; in the latter case the globose, subglobose or hemispheric apical portion becomes attenuated gradually or suddenly into a cylindrical, stout, smooth, stem-like base, which is attached to the substratum by mycelial threads. *Exoperidium* thickly studded with minute, more or less persistent, straw-coloured, furfuraceous verrucae and granules on the basal part ; in the apical portion, the verrucae are rather more distant, slightly sunken, and interspersed with larger, darker, more pointed, more erect verrucae, the latter soon falling off and leaving minute (about 0.50 mm.) light-coloured, round, shallow depressions between the furfuraceous granules, which produce an areolated, sometimes reticulated effect. Small verrucae and granules ochraceous to olivaceous-brown, larger ones umber. *Endoperidium* straw-coloured, buff, greyish-brown, pale brown, olivaceous-brown (nearest

Isabella, Buffy Brown), smooth, often shining, minutely pitted or areolate where the verricæ have fallen off; opening by an apical, raised, torn mouth. *Sterile base* present, usually large, occupying the stem-like base, distinctly cellular, up to 1 mm. diam., dirty white, straw-coloured to pale brown, often centrally convex. No diaphragm present, but sterile base well demarcated from the gleba. *Gleba* old gold when mature, later greyish brown, olivaceous, chestnut brown, olivaceous-ochraceous (Buffy Brown, Saccardo's Umber) pulverulent. *Capillitium* threads long, copious, densely aggregated together at the central protruding point of the sterile base when present, tinted to brownish, olivaceous, chestnut brown, even or irregular in parts, non-septate, sparingly branched, varying in thickness up to much thicker than spores, smooth or with fragments of tissue slightly obscuring the walls. *Spores* globose, finely and closely verrucose, tinted to olivaceous,  $3.5-5 \mu$  diam., sometimes pedicellate in dry condition, pedicels deciduous, hyaline, up to  $10.2 \mu$  long.

*Habitat* : on ground or decayed vegetable matter, single, in groups or caespitose.

*Distribution* : North, East and South Africa; North and South America; Australia; Britain; Europe; India; Tasmania; New Zealand.

*Specimens examined* : Wilderness, C.P., May 1923, E. M. Dodge, 17794; Deepwalls, Knysna, J. Phillips (v. d. Byl 2221) 18147 as *L. gemmatum*; Kirstenbosch, April 1940, A. J. Middlemost (E. L. Stephens 517).

*Specimens not seen* : Uitenhage, Zeyher.

The peculiar verrucae of the exoperidium, which fall away, leaving the endoperidium areolate or reticulate, and the large, sterile, cellular base distinguish this species.

Cunningham finds the spores to be without pedicels, but in the South African specimens examined, many were found to be pedicellate, the pedicels falling off for the most part when mounted in water or lacto-phenol.

#### 6. *Lycoperdon Duthiei* n. sp., [Plate XXXIX, fig. 3.]

*Peridio* 2.7 cm. alto, 2.2 cm. lato, obovate vel piriformi basi in conformatiōnem caulis attenuato. *Exoperidio* ochraceo-umbrino, cum spinulis et raris verrucis tecto. *Endoperidio* ochraceo-griseo, nitido, parte superiore deinde areolata, ostiolo irregulare demum magno et lacerato. *Gleba* matura olivaceo-umbrina, basi sterili bene evoluta, cellulosa. *Septo* transverso nullo. *Capillitio* colorato, parce ramoso, usque  $7 \mu$  crasso. *Sporis* globosis, subglobosis, nonnullis ovatis et brevibus pedicellatis, levibus raro verrucosis, 4-6  $\mu$  diam., interdum  $7 \times 4 \mu$  diam., primo pallidis demum olivaceo-umbrinis.

*Habitat* in solo, Kirstenbosch, leg. Duthie, 35338.

*Peridium* 2-7 cm. high, 2-2 cm. wide, obovate or pyriform, attached by a thick rooting structure. *Exoperidium* ochraceous brown, covered with scattered warts and groups of connivent spines, which break away from the upper portion. *Endoperidium* ochraceous-grey, shining, areolate where exoperidial warts have fallen off; opening by an irregular apical mouth, which later becomes a large, torn aperture. *Gleba* olivaceous-brown to umber. *Sterile base* concave, well-developed, cellular, cells small, occupying the stem-like base. *Diaphragm* lacking. *Capillitium* threads olivaceous-brown, occasionally branched, varying in thickness up to the maximum spore diameter, but usually the size of the average spore. *Spores* globose or sub-globose, many spores slightly ovate and apiculate or shortly pedicellate (dry spores often pedicellate); sparsely verrucose, episporule dark and well defined; vacuole conspicuous; 4-6  $\mu$  diam., occasionally  $7 \times 4 \mu$ , pale to dark olivaceous brown.

*Habitat* : on ground.

*Distribution* : South Africa.

*Specimen examined* : Kirstenbosch, Duthie 44 pr. parte, 35337, Kew.

Unfortunately only one specimen of this species was available for examination, forming part of Dr. Duthie's collection No. 44, the remainder of which is *L. umbrinum*. It seems sufficiently distinct, however, from named species to warrant specific distinction. Its distinguishing features are the ochraceous brown exoperidium of groups of connivent spines and scattered warts, the well-developed, concave, sterile base of small cells and the ovate or subglobose, smooth spores. Miss Wakefield kindly compared this specimen with descriptions and material of *Lycoperdon* spp. at Kew but found that it differed in one respect or another from all of them.

#### 7. *Lycoperdon caffrorum* Kalchbrenner et Cooke.

Grevillea 10 (1882) 109.

Massee, Journ. Roy. Micr. Soc. (1887) 707; Sacc. Syll. Fung. 7 (1888) 129.

*Peridium* 5-7 cm. wide, 4-6 cm. high, pyriform, tapering towards the base. *Exoperidium* furfuraceous, fugacious. *Endoperidium* ferruginous, bay brown (Verona Brown) at first almost smooth, then breaking up into minute scales. *Gleba* brownish-olivaceous (Tawny Olive). *Sterile base* present, light brown, compact, indistinctly cellular. *Diaphragm* lacking. *Capillitium* threads hyaline to tinted olivaceous, pitted, sparingly branched, non-septate. *Spores* olivaceous brown, globose, average size 4  $\mu$  diam., finely verrucose.

*Habitat* : on ground.

*Distribution* : South Africa.

*Specimen examined* : in grassy places, Boschberg Mts., Somerset East, 1879, MacOwan 1424, 22059, Type.

MacOwan's specimens No. 1003, 22060, labelled *Lycoperdon gemmatum* L., (sub. *L. caffrorum* Kalchbr. & Cooke in Fungi MacOwaniani) are believed to be *L. hyemale* and are referred to this species. They show the typical exoperidium, well developed cellular base, diaphragm and septate, hyaline capillitium threads.

According to Kalchbrenner and Cooke, *L. caffrorum* somewhat resembles *L. Gardneri* Berk., but is smaller, deeper coloured, with spores not so rough.

#### 8. *Lycoperdon caespitosum* Welwitsch et Currey.

Fungi Angolenses in Trans. Linn. Soc. 26 (1870) 289.

Massee, Journ. Roy. Micr. Soc. (1887) 725; Sacc. Syll. Fung. 7 (1888) 120.

*Peridium* 0.5-4 cm. diam., globose, strongly rooting. *Exoperidium* white, verrucose or finely furfuraceous, for the most part fugacious. *Endoperidium* (Cinnamon Brown) drying yellowish white, parchment-like in weathered specimens, finally membranaceous, smooth and polished. *Gleba* ochraceous brown (Tawny Olive). *Sterile base* wanting. *Capillitium* threads hyaline to tinted yellowish or clay-coloured liliaceous, sparingly branched, occasionally septate, punctate, of varying thickness, from smaller to larger than spore diameter. *Spores* almost hyaline to olivaceous-yellow, yellowish liliaceous, 2.5-5  $\mu$  diam. (Massee l.c., gives 5-6  $\mu$  diam.), thick walled, obscurely verrucose when mature.

*Habitat* : on ground, caespitose, gregarious.

*Distribution* : South Africa.

*Specimen examined* : in open grassy places near Somerset East, MacOwan 1005 a, 22058, Kew.

*Specimens not seen* : in upland poor meadows, Morre de Lopollo, Huilla, Welwitsch 145.

MacOwan has numbered both *L. caespitosum* and *L. flavum* 1005, the first-named is therefore referred to as 1005 a and the second 1005 b.

9. **Lycoperdon flavum** Massee, [Plate XXXVI, fig. 1, 2.]

Journal of the Royal Microscopical Society (1887) 721.

*Peridium* up to 2 cm. high, 3·5 cm. wide, pulvinate, abruptly constricted into a rooting base. *Exoperidium* smooth, ochraceous-yellow, finally Chestnut Brown with scattered white flecks. *Endoperidium* thick, smooth, cheesy and yellow when young, becoming Chestnut Brown, flaccid and papery, dehiscing by an apical mouth. *Gleba* yellow, finally dark grey (Dusky Drab). *Sterile base* absent. *Capillitium* threads almost hyaline to pale brownish-olivaceous, sparingly branched, sparsely if septate, wavy, occasionally with small projections, varying considerably in thickness up to diameter of spores. *Spores* globose, pale brownish-olivaceous, finely verrucose when mature, 4–5  $\mu$  diam.

*Habitat* : in grass lawns after continuous rains, solitary or caespitose.

*Distribution* : South Africa.

*Specimens examined* : Pretoria, Jan. 1939, A. M. Bottomley, 35528, January 1943, E. Scott, 34580, and numerous previous collections from the same locality.

*Specimens not seen* : Cape, MacOwan 1005 b, Kew (cf. note on *L. caespitosum*).

The distinguishing features of this species are the smooth, ochraceous-yellow exoperidium, the yellow, cheesy consistency of the mature plant and the usually deliquescent nature of the mature gleba. Collections have only been made during very wet spells in summer, and unless collected when immature, and brought indoors, the whole plant deliquesces at maturity into a wet pulp, changing from a clear ochraceous-yellow, solid, cheesy structure to a soft, wet, brown mass. When kept indoors, the endoperidium turns a chestnut brown and becomes flaccid and papery, while the gleba becomes pulverulent.

The above description differs from the original in larger size, absence of spines on the capillitium threads and the deliquescent character. An examination of the original material at Kew, kindly made by Miss Wakefield, did not reveal any trace of the "spiny" capillitium described by Massee and the other characters may vary under different climatic conditions. Since the plants otherwise appear to agree with Massee's plant, and do not fit in better with any other described species, they are tentatively referred to *L. flavum*, although the latter is only known from MacOwan's original dried material and may be found to be synonymous with some other species.

10. **Lycoperdon polymorphum** Vittadini, [Plate XXXVIII, fig. 1.]

Monographia Lycoperdineorum (1842) 39.

*Lycoperdon coloratum* Peck, N.Y. Nat. Hist. Mus., 29th Rept. (1878) 29.

*L. cepaeforme* (Bull.) Mass., Journ. Roy. Micr. Soc. (1887) 722.

*L. furfuraceum* Schaeff. ex de Toni, Sacc. Syll. Fung. 7 (1888) 110.

*L. hungaricum* Hollós, Mathem. Term. 69 (1901) 1.

*L. nigrum* Lloyd, Myc. Writ. 1, Lyc. Aus. (1905) 30.

*Peridium* 1·2–4 cm. wide, 1·5–3·5 cm. high, depressed-globose or sub-pyriform when contracted into a more or less lacunate, stalk-like base. *Exoperidium* furfuraceous or of minute verrucae, fugacious or more or less persistent in lower part, whitish or ochraceous, becoming ochraceous-brown, olivaceous brown (Old Gold, Buffy Brown), umber or blackish-brown (Tawny Olive, Snuff Brown). *Endoperidium* ochraceous, ochraceous-brown, olive brown (Old Gold, Buffy Brown) becoming olivaceous-brown, umber or blackish brown; papery, smooth, dull or polished, dehiscing by a torn, apical mouth. *Gleba* yellowish becoming olivaceous, olivaceous-brown or umber. *Sterile base* present, scanty or well-

developed, compact, usually consisting of closely interwoven hyphae resembling the capillitium threads, or occasionally very obscurely cellular; cream, becoming greenish-yellow olivaceous, slate grey, brownish-grey, finally brown (Warm Sepia or Snuff Brown). *Diaphragm* absent. *Capillitium* threads pale olivaceous, brownish to deep brown, sparingly or freely branched, straight or wavy, smooth or occasionally slightly nodose, varying in thickness from smaller to larger than diameter of spores. *Spores* globose, subglobose broadly oval, long oval or slightly ovate, oval shape predominating,  $3\cdot4-5\cdot5\ \mu$  diam., occasionally up to  $6\cdot8\ \mu$  diam. in the case of oval spores, tinted brown or olivaceous, obscurely to strongly verrucose; apiculate to shortly pedicellate; pedicels sometimes up to  $8\cdot5\ \mu$  long; concolorous, wedge-shaped structures sometimes mixed with the spores.

*Habitat* : solitary or gregarious in grassy places or under trees and bushes.

*Distribution* : South Africa; North America; Australia; Britain; Europe; New Zealand.

*Specimens examined* : Pretoria, April 1913, *I. B. Pole Evans* 6683, May 1919, *H. V. King* 12339, Jan. 1928, *L. Reinecke* 23138; Garstfontein, Pretoria, February 1939, *A. M. Bottomley*, 30704; *P. J. Pienaar*, April 1911, 1355; Roseville, Pretoria, March 1911 *P. J. Pienaar*, 1939; Rietvlei, Pretoria, March 1945, *A. M. Bottomley*, 34590; Wonderboom, Pretoria, March 1917, *H. A. V. King*, 10051, det. Lloyd; Meintjes Kop, Pretoria, March 1925, *A. M. Bottomley*, 20390; Vereeniging, January 1926, *E. Brandmuller*, 20635; Ingogo, Natal, May 1920, *A. O. D. Mogg*, 13796; Papegaaisberg, *A. V. Duthie* 303 (v. d. Byl 2035) 31471; King's Park, Bloemfontein, *G. Potts* 7174, 13001; Lennard, 20653; Fountains Valley, Pretoria, March 1936, *A. M. Bottomley* *B. Louwrens*, 28592; without locality (P. v. d. Byl 1421), ex Herb. Lloyd; Forest Hall, Knysna, Feb. 1918, *A. V. Duthie* 211, 31400 as *L. oblongisporum*; Potchefstroom, Tvl., July 1935, *J. Sellschop*, 28515.

This species is characterised by its compact, sterile base composed of closely interwoven hyphae, resembling the structure of the fertile part. This may be well-developed or scanty, and in the latter case the plant is difficult to distinguish from *L. pusillum* which has no sterile base. The latter species is, however, smaller, smoother and more globose. The specimens listed above are considered to be the South African form of *L. polymorphum* differing from that found elsewhere in the shape of the spores, which are not typically globose, but vary from globose and subglobose to broadly oval, elliptic oval and sub-ovate, with the broadly oval or elliptic oval shapes always predominating. The oval spores suggest *L. oblongisporum* Kalchbr. & Cooke, and in fact Lloyd identified *Duthie 211* as that species, with the remark that this species corresponds to *L. cepaeforme* (a small form of *L. polymorphum*) in every respect except the shape of the spores. According to Lloyd [Myc. Writ. 2, Myc. Notes 20 (1905) 235] the sterile base of *L. oblongisporum* is scanty and composed of minute cells; the presence of the characteristic sterile base appears to be sufficient justification for referring the South African plant to *L. polymorphum*. Verwoerd (Ann. univ. Stell. 3, 1925 : 32) follows Lloyd in considering *Duthie 211* as *L. oblongisporum*; he does not deal with any *polymorphum* form.

11. *Lycoperdon pusillum* Batsch ex Persoon, [Plate XXXVIII, fig. 2, 3.]

Journal de la Botanique 2 (1809) 17.

Hollós, Gastero. Ung. (1904) 107; Rea, Brit. Basid. (1922) 37; Coker & Couch Gastero. (1928) 91; Bresad. Icon. Myc. 23 (1932) 1139; Verwoerd, Ann. Univ. Stell. 3 (1925) 3; G. H. Cunningham, Gastero. (1944) 152.

*Bovista pusilla* Pers., Syn. Meth. Fung. (1801) 138.

*Lycoperdon dermatoxanthum* Vitt., Monogr. Lyc. (1842) 34.

*L. reticulatum* Berk., Fl. N.Z., 2 (1855) 190.

*L. mundula* Kalchbr. ex Kalchbrenner & Cooke, Grev. 9 (1880) 3.

*L. pseudopusillum* Hollós, Noev. Koezl., 2 (1903) 75.

*Globaria samoense* Bres. ex Lloyd, Myc. Writ. 1, Myc. Notes 5 (1901) 50.

*Lycoperdon semi-immersum* Lloyd, Myc. Writ. 7, Myc. Notes 73 (1924) 1306.

*Peridium* 1-2 cm. diam., globose or subglobose, strongly rooting by a single or branched mycelial thread. *Exoperidium* white, then yellowish, consisting of fugacious or partly persistent, floccose or mealy squamules, which may split up into flattened verrucae and furfuraceous fragments, which give the mature plant a slightly areolated appearance. *Endoperidium* white or yellow, becoming pale brown and finally umber (Buffy Brown), very thin and papery, smooth, shining, dehiscing by a small, irregular apical pore. *Gleba* white, then yellow, finally greyish-brown, light olivaceous-brown or olivaceous (Olive Lake finally Buffy Brown). *Sterile base* absent. *Capillitium* threads subhyaline to ochraceous or olivaceous-brown, smooth or pitted, straight or wavy, even or with rounded or pointed projections, sparingly or freely branched, up to 6  $\mu$  diam. *Spores* globose, sometimes subglobose, obconic or broadly oval, smooth or obscurely verrucose, subhyaline or tinted olivaceous, 3.4-6  $\mu$  diam., often apiculate, sometimes pedicellate; pedicels, when present, hyaline; spores sometimes in long, sub-persistent bundles.

*Habitat*: on wet ground, solitary or gregarious.

*Distribution*: East and South Africa; North America; Asia; Australia; Britain; Ceylon; China; Europe.

*Specimens examined*: Pretoria, January 1943, *A. M. Bottomley* E. Scott, 33773; *L. Reinecke*, 23150; Jan. 1939, *A. M. Bottomley*, 35529; Gezina, Pretoria, February 1912, *Rev. N. Roberts*, 2044; Papegaaisberg, Stellenbosch, *Duthie* 318, 31483; Brandfort, Schonken (Duthie 296) 31465; King's Park, Bloemfontein, March 1917, *G. Potts* 7175, 13002; Bloemfontein, *G. Potts* 7183, 13007; Alicedale, May 1919, 12185 (spores oval, obconic); Potchefstroom, July 1935, *J. Sellschop*, 35527; Salisbury, S. Rhodesia, *Hopkins*, (P. v. d. Byl 2539); Nov. 1932, *Eyles* 7220 (S. Rh. 3915); Avondale, S. Rhodesia, Dec. 1928 (S. Rh. 153); without locality (v. d. Byl 2082); Garstfontein, Pretoria, Jan. 1946, *A. M. Bottomley*, 35427.

*Specimens not seen*: Somerset East, *Tuck* (MacOwan 115 b).

This species is characterised by its small, subglobose, rooting peridium, the absence of a sterile base and its usually freely branched capillitium. It varies considerably, however, in the size of the peridium, the size and degree of roughness of the spores and the branching of the capillitium.

In very wet weather, the gleba partially deliquesces from the base upwards (fig. 2) making the whole plant soft, wet and olivaceous-brown and sometimes results in complete collapse. Under dry conditions the plant behaves normally.

## 12. *Lycoperdon Qudenii* n. sp., [Plate XXXIX, fig. 2.]

*Peridio* 3.2 cm. alto 2 cm. lato, piriformi, deorsum in stipitem attenuato. *Exoperidio* verrucis furfuraceis umbrino-nigris dense ornato, verrucis a superiore parte demum secentibus. *Endoperidio* argenteo-griseo vel griseo-umbrino, levi, apice areolato. *Gleba* umbrina, pulverulenta. Parte sterili cellulosa, ochracea, concava et a parte fertile per septum distincte separabili. *Capillitio* olivaceo-umbrino, parce vel saepe ramoso, septis nullis, crassitudine variabile, plerumque spora adaequante. *Sporis* globosis subtiliter verrucosis, 4-5  $\mu$  diam., demum olivaceo-umbrinis, plerumque pedicellatis; pediculis hyalinis, tenuis ad 13.6  $\mu$  longis.

*Hab.* in sylvis, Qudenii, leg. *P. H. B. Talbot*, 34144.

*Peridium* up to 3·2 cm. high, 2 cm. wide, pyriform, narrowing sharply into a stem-like base; attached by mycelial threads. *Exoperidium* of closely and evenly distributed, brownish-black, furfuraceous verrucae or squamules, which are less dense on the stalk-like base and fugacious in the apical area. *Endoperidium* silver grey to pale greyish brown, smooth, becoming finely areolated in the upper portion, due to the disappearance of the fugacious verrucae. *Gleba* umber, pulverulent. *Sterile base* well developed, occupying the stem-like base, large cellular, ochraceous, concave. *Diaphragm* present, well defined. *Capillitium* threads olivaceous-brown, usually darker than the spores, sparingly to fairly frequently branched, non-septate, varying in thickness up to larger than the diameter of the spores, but usually of the same size. *Spores* globose, finely verrucose, 4-5  $\mu$  diam., pale to dark olivaceous brown, with darker, well defined episore, usually pedicellate; pedicels hyaline, slender, up to 13·6  $\mu$  long.

*Habitat* : on humus in forest.

*Distribution* : South Africa.

*Specimens examined* : Quden Forest Reserve, Zululand, 18-2-45, P. H. B. Talbot, 34144, Kew.

The distinguishing features of this species are its pyriform shape, the brownish-black furfuraceous verrucae, the large, cellular sterile base and the pedicellate spores. In the only two specimens of the above collection, the cellular base had almost completely disintegrated and disappeared, exposing the concave diaphragm.

Miss Wakefield kindly compared part of the above collection with material of *Lycoperdon* spp. at Kew, but was unable to match it.

### 13. *Lycoperdon umbrinum* Persoon.

*Synopsis Methodica Fungorum* (1801) 147.

Lloyd, *Myc. Writ.* 2, Notes 19 (1905) 209; *Myc. Writ.* 3, Notes 33 (1909) 438; Hollós, *Gastero. Ungar.* (1904) 96, 166; Verwoerd, *Ann. Univ. Stell.* 3 (1925) 31.

*Lycoperdon hirtum* Martius, *Flor. Erlang.* (1817) 386.

*L. gemmatum* *hirtum* Fries, *Syst. Myc.* 3 (1829) 38.

*L. sylvaticum* Wettstein, *Vorarb. Pilzfl. Steierm.* (1885) 575.

*L. atropurpureum* Vitt., *Monogr. Lycop.* (1842) 42.

*L. laxum* Bonordon, *Botan. Zeitg.* (1857) 614.

*L. pyriforme* Bull., *Champ.* 1, p. 148.

*L. glabellum* Peck, *U.S. Lycop. in Trans. Albany Inst.* 9 (1879) 314; Hollós, *Gastero. Ungar.* (1904) 101.

*Peridium* 2·7-3·5 cm. high, 2-3·2 cm. wide, varying considerably in size and shape from subglobose, obovate, egg-shaped to pyriform, with wrinkled stem-like base; attached by mycelial threads. *Exoperidium* of minute, evenly distributed, brownish-black verrucae, which are often fugacious in the apical region. *Endoperidium* ochraceous-brown, smooth, becoming areolate where the verrucae of the exoperidium fall off; opening by an irregular, apical mouth. *Gleba* umber with purplish tint, columella present. *Sterile base* well-developed, cellular, convex, ochraceous-brown. *Capillitium* threads varying in thickness from thin to 6·8  $\mu$  diam., almost hyaline to dark brown, copious. *Spores* globose, closely and finely verrucose, 4-5·2  $\mu$  diam., tinted to pale olivaceous brown, episore not well defined; often fairly long-pedicellate in the dry condition, when pedicels hyaline, up to 10·2  $\mu$  long; when mounted in lacto-phenol, only occasionally pedicellate.

*Habitat* : on ground.

*Distribution* : South Africa; North America; Europe.

*Specimens examined* : Kirstenbosch, C.P., A. V. Duthie 44 (v. d. Byl 2036 ; Stell. 182) 31315.

*Specimens not seen* : Brandfort, A. V. Duthie 296 ; Stellenbosch, A. V. Duthie 218.

This species is very variable in colour, size and shape, but can be distinguished by its rough exoperidium, cellular base and coloured capillitium.

14. **Lycoperdon asperum** (Léveillé) de Toni, [Plate XXXVII.]

Saccardo, Sylloge Fungorum 7 (1888) 119.

G. H. Cunningham, Gastero. (1944) 154.

*Bovista aspera* Lév., Ann. Sci. Nat., ser. 3, 5 (1846) 162.

*Lycoperdon australe* Berk., Fl. Tas. 2 (1860) 266.

*Bovistella aspera* (Lév.) Lloyd, Myc. Writ. 1, Lycop. Aus. (1903) 29 ; Verwoerd, Ann. Univ. Stell. 3 (1925) 29.

*Peridium* up to 1.5 cm. diam., subglobose or depressed-globose, yellowish-brown to bay-brown, strongly rooting. *Exoperidium* consisting of closely set, short, blunt, stout, ochraceous spines, conniving in fours, finally falling away, sometimes leaving the endoperidium furfuraceous. *Endoperidium* membranaceous, straw-coloured, yellowish to bay-brown, smooth, dehiscing by a torn apical pore. *Gleba* light olivaceous. *Sterile base* scantily developed, minutely cellular ; no diaphragm. *Capillitium* threads subhyaline to light olivaceous, sparingly, if at all, branched, non-septate, up to slightly thicker than the spore diameter, often pitted. *Spores* hyaline with darker episporule, globose, 3.4-5  $\mu$  diam., smooth to minutely verrucose, often pedicellate, pedicels almost hyaline, acuminate, 8-20.4  $\mu$  long.

*Habitat* : Solitary or in small groups on ground.

*Distribution* : South Africa ; Australia ; Chile ; New Guinea ; Tasmania.

*Specimens examined* : Johannesburg, A. M. Bottomley, 8772 ; Belvidere, Knysna Duthie 310, 31477 as *Bovistella aspera* Lév., Duthie 312 as *B. aspera*, det. Lloyd.

*Specimens not seen* : Belvidere, Knysna, Duthie 67 (Stell. 170) ; Transvaal, P. v. d. Byl.

This species is recognised by its exoperidium of ochraceous, connivent spines, and the usually minute sterile base.

16. **Lycoperdon Gunnii** Berk., [Plate XXXIX, fig. 1.]

Flora Tasmaniae 2 (1860) 265.

C. G. Cunningham, Gastero. (1944) 154.

*Bovistella Gunnii* (Berk.) Lloyd Myc. Writ. 2, Lyc. Aus. (1905) 29.

*Peridium* up to 2.1 cm. diam., subglobose, ochraceous-brown, sulphur yellow, bay brown, rooting. *Exoperidium* ochraceous or whitish, furfuraceous, tomentose or with minute verrucae or warts, for the most part fugacious, sometimes leaving fragments of brown tomentum or white specks behind. *Endoperidium* becoming bay brown, flaccid, smooth and shining. *Gleba* greenish-yellow, olivaceous-brown (between Light Brownish Olive and Buffly Brown). *Sterile base* absent. *Capillitium* threads greenish-yellow or tinted olivaceous-brown, non-septate, sparingly or freely branched, diameter less than, to exceeding that of the spores. *Spores* tinted or olivaceous-brown, smooth or obscurely verrucose, globose, 4.2-5  $\mu$ , pedicellate ; pedicels persistent, up to 13.6  $\mu$  long, hyaline or tinted.

*Habitat* : solitary or in groups on ground.

*Distribution* : South Africa ; Australia ; Tasmania ; New Zealand.

*Specimens examined* : Wellington, C.P., May 1911, *A. M. Bottomley*, 1547 ; Stellenbosch, C.P., *A. V. Duthie* 302, 31470 ; Bloemfontein, March 1916, *G. Potts* (Grey Univ. Coll. Herb. 7177) 13003 ; Salisbury, S. Rhodesia, *F. Eyles* 2523, 14861.

The small size, lack of sterile base, furfuraceous exoperidium and persistent pedicellate spores distinguish this species.

**Doubtful, unknown and insufficiently described species.**

**Lycoperdon asperrimum** Welw. et Curr., [Plate XL, fig. 3.]

Trans. Linn. Soc. 26 (1868) 289.

Sacc. Syll. Fung. 7 (1888) 105.

*Peridium* about 1 inch high, subglobose. *Exoperidium* of sharp spines which disappear at maturity. *Endoperidium* cinnamon brown, papyraceous. *Capillitium* near reddish brown. *Spores* same colour as capillitium, globose,  $4 \mu$  diam., minutely echinulate. [Description ex Welwitsch & Currey l.c., and Saccardo (l.c.).]

*Habitat* : on ground.

*Distribution* : South Africa ; North America.

*South African Specimens* : on sand dunes on banks by Lagoa de Giraul, Mossamedes, Angola, 1859, Welwitsch 142 ; Maiombo, Mossamedes, 1859, Welwitsch 144.

Welwitsch and Currey make the following remarks with regard to the above collections :—"The spines of the spores (of No. 142) are so minute that they are seen with difficulty even under a high power. No. 144 seems to be the same species, but exhibits no spines on the peridium. The peridium, however, is larger, and the spores reach .0002 inch".

**Lycoperdon bicolor** Welw. et Curr., [Plate XL, fig. 2.]

Fungi Angollenses in Trans. Linn. Soc. 26 (1870) 290.

Sacc. Syll. Fung. 7 (1888) 119, 479.

*Peridium* 3.5-5 cm. high, 3.5-4 cm. wide, subglobose, attenuated towards the base into a white stipe about 15 mm. thick. *Endoperidium* leaden fuscous, membranaceous. *Capillitium* threads brown. *Spores* brown, globose,  $2.5-6 \mu$  diam., smooth. (In Sacc. Syll. Fung. l.c., the spores are given as  $2.5-5 \mu$  on page 119 and as  $5-6 \mu$  on page 479.) Description ex Welwitsch and Currey l.c. and Saccardo l.c.

*Habitat* : on the ground.

*Distribution* : West Africa, North Africa.

*South African specimens* : in very damp, woody pastures between Lopollo and Empalanea, Huilla, Welwitsch 146.

**Lycoperdon capense** Cooke et Massee, [Plate XL, fig. 1.]

Journ. Roy. Micr. Soc. (1887) 714, Pl. 16, fig. 450.

Sacc. Syll. Fung. 7 (1888) 48; Ed. Fischer, Hedw. 28 (1889) 7; P. Henn., Engl. Bot. Jahrb. 14 (1892) 360.

*Peridium* about 5 cm. diam., globose, sessile, plicate below with a long, stout, tapering root. *Exoperidium* minutely furfuraceous, fugacious. *Endoperidium* becoming smooth. *Gleba* yellowish brown, dense. *Capillitium* threads of uniform thickness, about equal in diameter to spores, simple, much interlaced and curled, continuous with the compact, basal stratum. *Spores* bright ochre, tinged citron, globose,  $4 \mu$  diam., smooth.

*Habitat*: on the ground.

*Distribution*: South Africa.

*South African specimens*: Cape of Good Hope; Ombale, Ondongo, South-West Africa, Schinz.

With regard to the two species *L. capense* Fr. and *L. capense* Cooke et Massee, Miss Wakefield makes the following remarks:—"Fries in *Fungi natalenses*, p. 150 (p. 30 of reprint) has these two names for two fungi received from the Cape (Zeyher 106) and Natal (Wahlberg) respectively. Of *L. capense* he gives a description which I think validates the name. Therefore Cooke and Massee's "*L. capense*" is a later homonym of *L. capense* Fr. and will have to be renamed if it proves to be a good species". No material of *L. capense* Cooke & Mass. is available for study, so there is no alternative but to include this species amongst the doubtful species.

**Lycoperdon capense** Fries.

*Fungi Natalenses* (1848) 150.

*Peridium* has the habit of *L. gemmatum* but the structure rather of *L. pusillum*. *Exoperidium* granular. *Endoperidium* membranous, flaccid, opening by a small, obtuse mouth. *Sterile base* wanting. *Capillitium* threads very lax. *Spores* brown, not becoming olivaceous. (Description ex Fries l.c.)

*Habitat*: on ground.

*Distribution*: South Africa.

*South African specimens*: Uitenhage, Zeyher 106.

This collection is probably at Upsala.

**Lycoperdon Curreyi** Massee.

Journ. Roy. Micr. Soc. (1887) 706.

*Lycoperdon Welwitschii* de Toni, Sacc. Syll. Fung. 7 (1888) 127 (non *L. Welwitschii* Mass., 1887); Verwoerd, Ann. Univ. Stell. 3 (1925) 32.

*L. radicatum* Welw. et Curr., Trans. Linn. Soc. 26 (1868) 289; Kalchbrenner, Grev. 10 (1882) 108 (non Dur. et Mont.).

*L. atro-violaceum* Kalchbr. (nom. nud.), in Herb. S. African Mus.

*Peridium* 3–10 cm. diam., subglobose to obovate, strongly rooting. *Exoperidium* smooth, finely tomentose, more or less fugacious, buff coloured, becoming purplish umber. *Endoperidium* almost smooth, papery, fragile, reddish brown or clay coloured (Saval Brown, Avellaneous). *Gleba* ochraceous or straw-coloured finally greyish or dull brown with purplish tinge and very pulverulent. *Sterile base* well developed, up to one-third of the total height,

concave, cellular, finally chocolate brown in colour. *Diaphragm* present. *Capillitium* threads subhyaline, varying in thickness up to the size of the spore diameter, sparingly branched, septate, finally fragmenting. *Spores* globose, hyaline to tinted olivaceous, almost smooth to sparsely or strongly echinulate,  $5.2-7 \mu$  diam.

*Habitat* : on ground.

*Distribution* : South Africa.

*Specimens examined* : Boschberg Mts., Somerset East, *MacOwan 1004*, 22062 as *Lycoperdon radicatus*; ? 1875, *MacOwan 1004* (S.A.M. 35050) as " *L. atroviolaceum* Kalchbr. type"; Dec. 1874, *MacOwan 1004* (S.A.M. 35050) as *L. atroviolaceum* (*L. radicum*); April 1879, *MacOwan 1004* (S.A.M. 35050) as " *L. atroviolaceum* "; *MacOwan 1009* as " *Bovista lilacina* (*L. radicum*) " 22061; *MacOwan 1009* (S.A.M. 35050) as " *L. atroviolaceum* Kalchbr. nom nud ".

*Specimens not seen* : very rare, in grassy places, Loanda, Penedo distr., West Africa, 1854, *Welwitsch* No. 116.

The specimens deposited in the South African Museum at Cape Town and especially the 1879 collection appear to be typical *Calvatia lilacina*. The specimens at Pretoria of both *MacOwan 1004* and *1009* may be immature *C. lilacina* but are smaller, more globose, with very little sterile base and, while the gleba of No. *1009* is tinged with purple, that of No. *1004* is a uniform buff colour without any trace of purple colouration.

In addition to the above specimens of *MacOwan 1004*, this number is quoted by Kalchbrenner (Grevillea 10, 1882 : 108) for *L. cyathiforme* which is regarded as a synonym of *C. lilacina*, and is attached to a specimen at Kew named *L. MacOwani*. In connection with the latter, Miss Wakefield states that the specimen does not appear to be *C. lilacina* since no violet colour is present.

**Lycoperdon Gardneri** Berkeley.

Berkeley and Broome, Ceylon Fungi No. 716 in Journ. Linn. Soc. 14 (1873) 79.

Massee, Monogr. Lycop., Journ. Roy. Micr. Soc. (1887) 716; Sacc. Syll. Fung. 7 (1888) 129, 482.

*Peridium* 11-12 cm. diam., hemispherical, plicate below, contracted into a thick, rugose, rooting stem. *Endoperidium* tawny, minutely floccose or mealy. *Capillitium* persistent, threads pallid, rarely branched, flaccid, flexuous or contorted. *Sterile base* present, compact. *Spores* pale ochraceous, subglobose, slightly produced at the point attached to the persistent pedicel, smooth, longest diameter  $4-5 \mu$  (description ex Massee, l.c.).

*Habitat* : on ground in shady woods.

*Distribution* : South Africa; Ceylon; Venezuela.

According to Berkeley and Broome (l.c.) this species was formerly referred to *L. saccatum* but further specimens showed it to be distinct. The large size, compact sterile base and persistent spore pedicels appear to be the distinguishing features of this species. The presence or absence of a diaphragm is not mentioned.

**Lycoperdon glabellum** Peck.

N.Y. Nat. Hist. Mus., Bot., 31st Rept. (1879) 39.

Kalchbrenner, Grev. 10 (1882) 109; Massee, Journ. Roy. Micr. Soc. (1887) 707; Sacc. Syll. Fung. 7 (1888) 124, 477; Hollós, Gastero. Üng. (1904) 101.

*Peridium* 2.5-4 cm. wide, subglobose or turbinate, sometimes narrowed below into a short, stem-like base. *Exoperidium* furfuraceous, with minute, sub-uniform, persistent

warts. *Endoperidium* yellow or brownish-yellow, dehiscing by a small mouth. *Gleba* purplish-brown; columella present. *Capillitium* purplish-brown. *Spores* concolorous, rough, globose, 5-6  $\mu$  diam. (Description ex Peck, l.c. and Saccardo, l.c.)

*Habitat*: on the ground.

*Distribution*: United States; South Africa.

*South African specimens*: Somerset East, MacOwan 1337; Bazuja, Kaffraria, Baur.

Saccardo states that this species is near to *L. cupricum*, and that, according to Kalchbrenner, it is a doubtful species, even in Africa. Hollós cites it as a variety of *L. umbrinum*.

***Lycoperdon laetum* Berk.**

Hooker's London Journal of Botany 2 (1843) 419.

Massee, Journ. Roy. Micr. Soc. (1887) 718; Sacc. Syll. Fung. 7 (1888) 483.

*Peridium* about 4 cm. high, 5 cm. wide, subglobose or lenticular, contracted into a stout, stem-like cellular base about 1.8-2 cm. high, 2.5 cm. thick, or base almost obsolete. *Exoperidium* reddish-brown, subcoriaceous, sulcate, becoming furfuraceous or almost smooth, pale; breaking away in rimosely areolate patches from the upper portion, leaving a cup-like opening. *Gleba* pale reddish-brown. *Sterile base* large, occupying the stem-like portion, cellular, spongy, compact. " *Capillitium* sublenticular, hollowed beneath, yellow; flocci pellucid, branched, not rough". *Spores* yellow, then yellow-olive, globose, minute, smooth, not or very shortly pedicellate. (Description ex Berkeley, l.c., Massee, l.c., and Saccardo, l.c.)

*Habitat*: on the ground.

*Distribution*: South Africa.

*South African specimens*: Uitenhage, Zeyher 103.

Berkeley says of this species:—" This species, which is very peculiar, has more the appearance of a *Scleroderma* than of a *Lycoperdon*, though its structure is that of the latter. It resembles in some respects *L. caelatum*. The peridium is, however, more rigid, and opens, apparently, not by the mere collapsing of the centre, but by coarse cracks. It varies with a distinct stem, and is altogether confluent with the peridium; but even then, the distinction between the stem and peridium is marked".

***Lycoperdon natalense* Fries.**

Fungi Natalenses in K. Vet. Ak. Handl., Stockholm (1848) 150.

? nomen nudum.

The following note on this species was supplied by Miss Wakefield:—" Fries did not describe *Lycoperdon natalense* except for saying that it was near *L. caelatum* and differed in its vinaceous or pale purplish spores (this sounds like *Calvatia lilacina*) and if there is no specimen of *L. natalense* in Fries's herbarium at Upsala, by which it could be identified, I think the name may be regarded as a *nomen nudum* and in that sense Cooke and Massee were free to use it again"!

With regard to *L. natalense* Cooke & Massee, G. H. Cunningham (Gastero. 1944: 146) considers this species to be a synonym of *L. depresso* Bonord., which is the same as *L. hyemale* (Bull. ex Pers.) Vitt.

## Excluded Species.

The following species, recorded as having been collected in Southern Africa, are considered to be synonyms of other species or genera and have been listed as such in the foregoing pages:—

<i>Lycoperdon atro-violaceum</i> Kalchbr.	<i>L. Curreyi</i> Massee.
<i>L. separaliforme</i> (Bull.) Mass.	<i>L. polymorphum</i> Vitt.
<i>L. Curtissii</i> Berk.	Prob. <i>L. hyemale</i> (Bull. ex Pers.) Vitt.
<i>L. cyathiforme</i> Bosc.	<i>Calvatia lilacina</i> .
<i>L. depressum</i> Bon.	<i>L. hyemale</i> (Bull. ex Pers.) Vitt.
<i>L. dermatoxanthum</i> Vitt.	<i>L. pusillum</i> Batsch ex. Pers.
<i>L. Eylesii</i> Verwoerd.	<i>L. hyemale</i> (Bull. ex. Pers.)Vitt.
<i>L. excipuliforme</i> (Scop.) Vitt.	<i>L. perlatum</i> Pers.
<i>L. furfuraceum</i> Schaeff. ex de Toni	<i>L. polymorphum</i> Vitt.
<i>L. gemmatum</i> (Batsch) Fr.	<i>L. perlatum</i> Pers.
<i>L. glabellum</i> Peck.	<i>L. umbrinum</i> Pers.
<i>L. multiseptum</i> Lloyd.	<i>L. hyemale</i> (Bull. ex Pers.) Vitt.
<i>L. natalense</i> Cooke Mass.	<i>L. hyemale</i> (Bull. ex Pers.) Vitt.
<i>L. oblongisporum</i> Berk Curt.	<i>L. polymorphum</i> Vitt.
<i>L. pratense</i> Pers.	<i>L. hyemale</i> (Bull. ex Pers.) Vitt.
<i>L. radicatum</i> Welw. Curr.	<i>L. Curreyi</i> Mass.
<i>L. retis</i> Lloyd.	<i>Calvatia candida</i> (Rostk) Hollós (sec. G. H. Cunningham).
<i>L. saccatum</i> Vahl.	<i>Calvatia saccata</i> (Vahl ex Fr.) Morgan.
<i>L. Welwitschii</i> de Toni.	<i>L. Curreyi</i> Massee.
<i>L. MacOwanii</i> (unpublished name) referred by Verwoerd in Ann. Univ. Stell. 3 (1925) 33 to <i>L. Welwitschii</i> de Toni.	

## 2. DISCISEDA Czernaiaev.

Bulletin de la Société Imperiale des Naturlistes de Moscou, 18 (1845) 153.

*Catastoma* Morgan, Journ. Cincinnati Nat. Hist. 14 (1892) 142.

*Bovistoides* Lloyd, Myc. Writ. 6, Myc. Notes 61 (1919) 883.

Type species; *Disciseda collabescens* Czern.

Plants growing just below soil level or partially exposed. Peridium depressed-globose, consisting of two layers, an outer hyphal layer—the exoperidium—which becomes impregnated with sand and vegetable debris and at maturity breaks away circumscissilely, leaving an irregular, shallow, cup-shaped structure around the base, and an inner membranous, parenchymatous layer—the endoperidium—which surrounds the gleba and dehisces by means of a small aperture. Sterile base wanting. Gleba pulverulent. Capillitium threads short, simple or short-branched, non-septate. Spores coloured, globose, almost smooth to coarsely verrucose, pedicellate or not.

Cunningham has been followed in the arrangement of the key to the species.

## Key to the Species.

Spores long-pedicellate (10  $\mu$  or more)

Spores coarsely verrucose	1. <i>D. pedicellata</i> .
Spores finely verrucose	2. <i>D. juglandis</i> formis.
Spores almost smooth	3. <i>D. castanea</i> .

Spores non-pedicellate or apiculate

Spores coarsely verrucose, verrucae flat-topped forming a halo.....	4. <i>D. hypogaea</i> .
Spores echinulate with finger-like processes.....	5. <i>D. verrucosa</i> .
Spores coarsely spinulose.....	6. <i>D. Zeyheri</i> .
Spores finely verruculose	
Exoperidium thin, membranous.....	7. <i>D. anomala</i> .
Exoperidium thick, brittle.....	8. <i>D. cervina</i> .
Spores almost smooth, Gleba olivaceous-umber.....	9. <i>D. candida</i> .

1. **Disciseda pedicellata** (Morgan) Hollós, [Plate LXIV, fig. 3.]

Termesztrajzi Fuezetek 25 (1902) 103.

G. H. Cunningham, Gastero. (1944) 136.

*Catastoma pedicellata* Morg., Journ. Cincinnati Soc. Nat. Hist. 14 (1892) 143 ; Verwoerd, Ann. Univ. Stell. 3 (1925) 27.

*Peridium* 3 cm. diam., depressed globose. *Exoperidium* fairly thick and hard, of sand and hyphae mixed, light greyish-brown, breaking away circumscissilely, leaving only a small basal cup not visible from the top. *Endoperidium* membranous, tough, umber (Natal Brown) in the lower half, paler brown (near Avellaneous) towards the apex, smooth, dull or shining, dehiscing by a torn, apical mouth. *Gleba* purplish brown, pulverulent. *Capillitium* threads abundant, tinted pale brown, smooth, spirally wavy, thinner than diameter of spores. *Spores* up to  $10.2 \mu$  diam., including the verrucae, globose, coarsely verrucose ; verrucae rounded, brown ; pedicellate, pedicels up to  $37.4 \mu$ , tinted, smooth, straight or curved.

*Habitat* : on the ground, solitary.

*Distribution* : South Africa ; North America ; Australia.

*Specimens examined* : Maputa Expedition, Mocambique, Aug. 1914, Dr. Breijer, 8355 ; Knysna, Duthie 207 (v. d. Byl 1426 ex. Herb. Lloyd).

2. **Disciseda juglandiformis** (Berkeley) Hollós.

Hedwigia 42 (1903) 22.

*Bovista juglandiformis* Berk., Massee in Journ. Bot. (1888) 130.

*Catastoma juglandiformis* (Berk.) Lloyd. Myc. Writ. 1, Myc. Notes 18 (1904) 199.

*Peridium* 2.5-3.7 cm. diam., subglobose, sessile. *Exoperidium* thick, persistent, cupulate at the base. *Endoperidium* polished, rigid, dark brown, mouth small, apical. *Gleba* olive-tinted rufous. *Capillitium* threads flaccid, pale, sparingly branched, much curled and intertwined. *Spores* brown, globose, minutely warted, about  $16 \mu$  diam., pedicellate ; pedicels long, 60-70  $\mu$ , thick, reddish olive. (Description adapted from Berkeley l.c.)

*Habitat* : on the ground.

*Distribution* : South Africa.

*South African records* : locality unknown, Type in Herb. Berk., No. 4584, Kew, as *Bovista juglandiformis* ; Brenton, Knysna, Duthie 153 (Lloyd, Myc. Coll. 52388).

According to Berkeley, l.c., this species is remarkable for the size of the spores and the very long, stout, coloured pedicels.

3. **Discisda castanea** (Lév.) n. comb.

*Bovista castanea* Lév., Ann. Sci. Nat., ser. 3, 5 (1846) 162.

*Catastoma castaneum* (Lév.) Lloyd, Myc. Writ. 2, Myc. Notes 23 (1906) 291.

*Peridium* about 3 cm. diam., globose. *Exoperidium* not described. *Endoperidium* parchment-like, black, byssoid below. *Gleba* bright olive. *Capillitium* threads dense. *Spores* globose, smooth, with long pedicels. (Description ex Massee, l.c.)

*Habitat*: solitary or in groups, on ground.

*Distribution*: South Africa.

*South African Records*: between Hex River Mts. and the Bokkeveld, Drége 9455a (Herb. Mus. Paris and Herb. Delessert, Geneva, as *Bovista castanea* Lév.); under *Eucalyptus globulus*, Maritzburg, T. R. Sim, 8796 (specimen not found).

4. **Discisda hypogaea** (Cooke & Massee) G. H. Cunningham.

Proceedings of the Linnean Society of New South Wales, 52 (1927) 240.

*Bovista hypogaea* Cke. & Mass., Grevillea 20 (1891) 35.

*Catastoma hypogaeum* (Cke. & Mass.) Lloyd, Myc. Writ. 1, Lyc. Aus. (1905) 27.

*Peridium* 9 mm. diam., depressed globose. *Exoperidium* falling away irregularly leaving a disc mixed with sand at base of plant. *Endoperidium* thin, flaccid, tough, greyish white, dehiscing by a mammose mouth. *Gleba* greyish brown, pulverulent. *Capillitium* threads tinted, sparingly branched. *Spores* globose, 7–9  $\mu$  diam., including the spines, pale brown with darker episporae, very closely and strongly verrucose, the tips of the verrucae spread out giving the appearance of a halo round the spores. (Description from a single specimen with weathered mouth.)

*Habitat*: in sandy soil.

*Distribution*: South Africa; Australia.

*Specimen examined*: eastern slopes of Bokkeveld, Aug. 1941, E. L. Stephens 562.

The species is characterised by the coarsely verrucose spores in which the flat-topped verrucae form a halo round the spores.

5. **Discisda verrucosa** G. H. Cunningham, [Plate LXIV, fig. 4.]

Transactions of the New Zealand Institute 57 (1926) 205.

G. H. Cunningham, Gastero. (1944) 140.

*Peridium* 2·2 cm. (3 cm.) diam., depressed globose. *Exoperidium* pale brown (nearest Avellaneous) hard, consisting of hyphae mixed with sand, breaking away from the apical portion, leaving an irregular, persistent, cup-like structure around the base, extending about one third of the total height of the plant. *Endoperidium* brown (Bay Brown) or pale greyish brown, dehiscing by a definite mammose pore (occasionally two) which becomes torn and irregular in old specimens. *Gleba* bay brown, pulverulent. *Capillitium* threads tinted brown, simple or occasionally short branched, non-septate, wavy, often spirally intertwined, thinner than diameter of spores. *Spores* 6·8–10·2  $\mu$  diam., including the verrucae, brown with darker episporae, which is covered with coarse, hyaline echinulae.

*Habitat*: solitary, on ground.

*Distribution*: South Africa; Australia; New Zealand.

*Specimens examined* : Grahamstown, C.P., March 1934, *N. J. G. Smith* 221, 27511, det. Cunningham; nr. Dordrecht, C.P., Feb. 1946.

The chief characteristics of this species are the definite mamlose stoma in fresh specimens and the echinulate spores.

**6. Disciseda Zeyheri (Berk.) Hollós.**

*Hedwigia* 42 (1903) 22.

*Bovista Zeyheri* Berk., in Massee, *Journ. Bot.* 26 (1888) 130.

*Catastoma Zeyheri* (Berk.) Lloyd, *Myc. Writ.* 5 (1917) Letter 65, p. 8; Verwoerd, *Ann. Univ. Stell.* 3 (1925) 27.

*Peridium* up to 3.7 cm. diam., subglobose, often with a small rooting base. *Exoperidium* thick, ochraceous, cupulate and persistent below. *Endoperidium* pale brown, dark purple or cinnamon, minutely granular or powdery, dehiscing by a small mouth. *Gleba* umber. *Capillitium* threads tinted to brown, undulating to much curled, 2.6-3.4  $\mu$  diam. *Spores* globose, 6-8  $\mu$  diam., brown, finely verrucose.

*Habitat* : on ground.

*Distribution* : South Africa.

*Specimen examined* : Mossel Bay, v. d. *Byl* 731.

*Specimens not seen* : without locality, Type in Herb. Berk. No. 4588, Kew, as *Bovista Zeyheri*; without locality, ? Knysna, *Duthie*.

**7. Disciseda anomala (Cooke et Massee) G. H. Cunningham.**

*Gasteromycetes of Australia and New Zealand* (1944) 139.

*Bovista anomala* Cooke et Massee, *Grev.* 18 (1889) 6.

*Catastoma anomalum* (Cooke et Massee) Lloyd, *Myc. Writ.* 1, *Lyc. Aus.* (1905) 27, 5 (1916) 610; Verwoerd, *Ann. Univ. Stell.* 3 (1925) 27.

*Peridium* up to 2 cm. wide, 1.5 cm. high, depressed-globose. *Exoperidium* brown, membranous, falling away, except at the base, where it persists as a small, irregular, sand-encrusted, cup-shaped structure. *Endoperidium* smoke or ash grey, membranous, thin but tough, smooth, obscurely furfuraceous, dehiscing either by a circular, flattened, tubular or mamlose mouth. *Gleba* olivaceous, becoming umber, pulverulent. *Capillitium* threads pale brown, in short or fairly long segments with blunt ends, occasionally shortly branched, usually smooth, even and wavy, varying in thickness up to diameter of largest spore. *Spores* darker than capillitium threads, globose, but occasionally obovate or broadly oval, finely and closely or sparsely verruculose, 3.4-6  $\mu$  diam., very short pedicellate, short stumps only of pedicels remaining.

*Habitat* : solitary or in small groups on ground.

*Distribution* : Africa; Australia.

*Specimens examined* : Mamathes, Basutoland, *A. Jacot-Guillarmod*, Oct. 1940, 34145; Phoenix, Natal, v. d. *Byl* 525'; Durban, v. d. *Byl* 237.

*Specimens not seen* : without locality, *Duthie*.

This species is characterised by its thin, tough, membranaceous exoperidium, its finely verruculose spores and its tubular or mamlose mouth.

According to Lloyd (Myc. Writ. 5, 1916 : 610) the South African form is not exactly the same as the usual Australian form, in that in the specimens examined by him (collected by A. V. Duthie) the mouth is mammose instead of tubular, the colour grey instead of rich brown and the spores smaller. In our No. 34145, however, not seen by Lloyd, the mouth is definitely tubular and the spores rather larger, up to  $6 \mu$  diam.

8. *Disciseda cervina* (Berkeley) Hollós.

*Hedwigia* 42 (1903) 22.

G. H. Cunningham, *Gastero.* (1944) 138.

*Bovista cervina* Berk., *Ann. Nat. Hist.* 9 (1842) 447 ; *Sacc. Syll. Fung.* 7 (1888) 100.

*Catastoma magnum* Lloyd, *Myc. Writ.* 5, *Myc. Notes* 45 (1917) 631 ; *Verwoerd, Ann. Univ. Stell.* 3 (1925) 27.

*Peridium* up to 2.5 cm., depressed globose. *Exoperidium* thick, breaking away circumscissilely, leaving an irregular, cinnamon brown, cuplike structure, composed of hyphae mixed with sand, at the base. *Endoperidium* thin, membranous, buff to pale tan coloured (Pinkish Buff, Cinnamon Buff) very finely granular, becoming smooth, dehiscing by a fimbriate, mammose mouth. *Gleba* olivaceous-brown. *Capillitium* almost hyaline to light brown, varying in thickness up to the diameter of the spores, for the most part smooth, occasionally simply and shortly branched, fairly straight. *Spores* globose, 5-6  $\mu$  diam., golden brown, finely verrucose, with stumps only of pedicels, episporic and wall of the single, conspicuous vacuole dark coloured.

*Habitat* : solitary, on ground.

*Distribution* : South Africa ; North America ; Australia ; Europe ; New Zealand.

*Specimens examined* : Schweizer Reinecke, Tvl., July 1929, *D. v. H.*, 34531.

*Specimens not seen* : near Cape of Good Hope (as *Bovista cervina*) ; Stellenbosch Flats, Duthie 282 (Lloyd Myc. Coll. 52392) ; under *Acacia caffra*, Commando Nek, Tvl., I. B. Pole Evans (Lloyd Myc. Coll. 52393) 8381 (specimen missing from Pretoria Herb.) ; Marienthal, S.W. Africa, R. Marloth, 26613.

The Australian plant as described by Cunningham, i.e., appears to be larger—up to 4 cm. diam.—with purplish or tan-coloured endoperidium and purplish or olivaceous gleba.

9. *Disciseda candida* (Schweinitz) Lloyd, [Plate LXIV, fig. 1, 2.]

*Mycological Writings* 1, *Mycological Notes* 10 (1902) 100.

*Bovista candida* Schw., *Syn. Fung. Carol.*, No. 333 (1822).

*B. circumscissa* Berk. & Curt., *Grev.* (1873) 50.

*Catastoma circumscissa* Berk. & Curt., *Morgan, Journ. Cincinnati Soc. Nat. Hist.* 14 (1892) 143.

*Disciseda circumscissa* (Berk. & Curt.) Hollós, *Term. Feuz.* 25 (1902) 102.

*Catastoma Duthiei* Lloyd, *Myc. Writ.* 6 (1919) 891.

*Peridium* (dry plant) up to 2 cm. diam., depressed-globose. *Exoperidium* thick, hard, consisting of hyphae mixed with vegetable debris, breaking away circumscissilely, leaving a shallow, cuplike structure at the base. *Endoperidium* drab, ferruginous to umber, tough, covered by a very thin, whitish, membranous layer, which flakes off, leaving a thick, spongy layer, which splits into minute longitudinal fissures towards the base, just above the exoperidial cup ; dehiscing by an apical, fimbriate, mammose mouth. *Gleba* olivaceous-umber, pulverulent. *Capillitium* threads abundant, almost hyaline to pale brown, varying in thickness up to thicker than spore diameter, occasionally short-branched, smooth,

comparatively straight, wavy or angled. Spores 4-5  $\mu$  diam., globose, non-pedicellate or very shortly and inconspicuously pedicellate, pale brown with darker epispor, almost smooth or finely and sparsely verruculose.

*Habitat*: solitary or in groups, on ground.

*Distribution*: South Africa; North and South America; Australia; New Zealand.

*Specimens examined*: under *Acacia caffra*, Commando Nek, Brits Distr., April 1914, I. B. Pole Evans, 8381; without locality, A. V. Duthie, 31514; Forest Hall, Knysna, A. V. Duthie 224 (Stell. 225; Lloyd Myc. Coll. 52391, Type of *Catastoma Duthiei*) 31411; Phoenix, Natal, Oct. 1925, Hardenberg (N.H. 622) 31862.

*Specimens not seen*: Queenstown, Pope, Kew, det. N. J. G. Smith.

Three sketches of this species, supplied by Dr. Duthie, show (1) the rooted plant with complete exoperidium (2) the plant with exoperidium splitting circumscissilely and (3) the plant with the remains of the exoperidium on the basal, rooted portion.

### 3. CALVATIA Fries.

*Summa Vegetabilium Scandinaviae*, Part 2 (1849) 442, emended Morgan, *Journal Cincinnati Society of Natural History* 12 (1890) 165.

*Hippoperdon* Mont., *Ann. Sci. Nat.*, ser. 2, 17 (1842) 121.

*Globaria* Quelet, *Bull. Soc. Myc. Fr.* 24 (1876) 370.

*Utraria* Quel., l.c., p. 366.

*Hypoblema* Lloyd, *Myc. Writ.* 1, *Myc. Notes* 14 (1903) 140.

Type species: *Calvatia craniiformis* (Schw.) Fr.

Plants epigeous, fairly small to very large. Peridium subglobose to pyriform, with or without a thick, short rooting base. Exoperidium thin, even, granular, areolated, furfuraceous, warty or spinulose, usually fugacious. Endoperidium thin, membranaceous, breaking away in irregular fragments from the apical portion. Gleba with sterile base or not, with or without a diaphragm. Capillitium threads long, or breaking up into short pieces, sparingly branched, septate or not. Spores globose or broadly elliptical, rough or smooth.

The genus *Calvatia* is most nearly related to *Lycoperdon* from which, however, it differs in the manner of dehiscence. Whereas *Lycoperdon* dehisces by means of an apical pore, *Calvatia* dehisces by the breaking away of the apical portion of the endoperidium.

#### Key to the Species.

Diaphragm present.	
Spores smooth.	1. <i>C. caelata</i> .
Spores verrucose.	2. <i>C. lilacina</i> .
Diaphragm absent.	
Plants large, up to 30 cm. diam.	
Exoperidium smooth. Sterile base scanty, poorly developed.	3. <i>C. gigantea</i> .
Exoperidium spinulose or granular.	
Sterile base large, well developed.	4. <i>C. saccata</i> .
Exoperidium tubercular or areolate with flattened warts. Sterile base absent.	5. <i>C. lepidophora</i> .

Plants small, up to 7 cm. diam.	
Exoperidium furfuraceous.	
Sterile base present.....	6. <i>C. candida</i> .
Sterile base absent.....	7. <i>C. incerta</i> .
Exoperidium tomentose, scanty, not separable.	
Sterile base absent.....	8. <i>C. pachyderma</i> .
Exoperidium of thick, pyramidal warts.	
Sterile base absent.....	9. <i>C. macrogemmae</i> .

1. *Calvatia caelata* (Bulliard) Morgan, [Plate XLII, fig. 1.]

Journal of the Cincinnati Society of Natural History 12 (1890) 169.

G. H. Cunningham, Gastero. (1944) 156.

*Lycoperdon caelatum* Bull., Champ. 1 (1809) 156 ; Sacc. Syll. Fung. 7 (1888) 115, 481.

*L. Fontanesii* Dur. et Mont., Fl. Alger. 1 (1849) 381.

*L. favosum* (Rostk.) Bon., Bot. Zeitung 15 (1857) 595.

*L. Sinclairii* Berk. in Herb., ex Massee, Journ. Roy. Micr. Soc. (1887) 716.

*Calvatia Fontanesii* (Dur. et Mont.) Lloyd, Myc. Writ. 1, Lyc. Aus. (1905) 36.

*C. Sinclairii* (Berk.) Lloyd, l.c., p. 37.

*C. bovista* (Pers.) Kambly & Lee, Univ. Iowa Stud. Nat. Hist. 17 (1936) 138, non MacBride 1896.

*Peridium* 5-9.5 cm. diam., egg-shaped or depressed globose, narrowing abruptly into a short, thick, crenulate rooting base. *Exoperidium* thick, membranaceous or felted, apically granular or covered with large, pale brown to olivaceous brown, closely set, pyramidal warts, which break away at maturity leaving the *endoperidium* areolate. *Endoperidium* parchment-coloured, becoming thin and brittle, breaking when touched, minutely furfuraceous, but smooth to the naked eye, pentagonally areolate, caused by the falling away of the exoperidial warts. Dehiscence by the breaking away of the apical portion in pieces. *Sterile base* small, about one-sixth of the total height, but well differentiated and separated from the gleba by a well-developed diaphragm. *Gleba* ochraceous at first, finally olivaceous brown, becoming very pulverulent, disintegrating when handled. *Capillitium* threads olivaceous, usually thicker than diameter of spores, sparingly and dichotomously branched, septate, fragmenting at maturity. *Spores* 3.4-5  $\mu$  diam., globose to slightly obovate when shortly apiculate, smooth, tinted to brown, episporic and wall of large single vacuole dark.

*Habitat* : on the ground, occurring singly.

*Distribution* : North and South Africa ; North America ; Australia ; Britain ; Europe ; New Zealand.

*Specimens examined* : Groenkloof, Pretoria, Nov. 1919, E. P. Phillips 12451.

This species is characterised by the finally areolate peridium, the well-defined sterile base and diaphragm and the smooth spores. The above specimens were identified by Lloyd as *C. Fontanesii* on account of the warts on the peridial wall.

2. *Calvatia lilacina* (Berkeley) P. Hennings, [Plate XLI, fig. 2, 3.]

*Hedwigia* 43 (1904) 205.

Lloyd, Myc. Writ. 1, Lyc. Aus. (1905) 35 ; Verwoerd, Ann. Univ. Stell. 3 (1925) 33 ; G. H. Cunningham, Gastero. (1944) 157.

*Bovista lilacina* Berk. et Mont., Hook. Journ. Bot. 4 (1845) 62.

*Lycoperdon novae-zelaniae* Lév., Ann. Sci. Nat. ser. 3, 5 (1846) 164.

*L. lilacinum* (Mont. et Berk.) Mass., Journ. Roy. Micr. Soc. (1887) 706.

*L. violascens* Cooke et Massee ex Massee l.c.

*L. cyathiforme* Bosc., Berl. Mag. d. Ges. naturf. Freunde 5 (1811) 87.

*Peridium* up to 11 cm. diam., subglobose or subpyriform, typical plants tapering abruptly into a well-developed, smooth or plicated base, attached by a short, thick, single or branched rooting structure. *Exoperidium* finely floccose, creamy white or ochraceous, finally chocolate, umber or bay brown (Cinnamon or Natal Brown) thin, fugacious, smooth, sometimes areolated. *Endoperidium* light greyish brown (near Wood Brown) sometimes with a metallic sheen, thin, fragile, breaking up and falling away in segments from the upper part, i.e. above the diaphragm. *Sterile base* usually well-developed, persistent, cellular, olivaceous, ochraceous or greyish to dark brown, separated from the gleba by a usually, but not always prominent diaphragm. *Gleba* ochraceous grey, finally purplish, dark grey with a purplish tinge or purplish brown, compact at first, becoming floccose and pulverulent and often completely disappearing. *Capillitium* threads long, but at maturity sometimes easily fragmenting at the septa, the pieces sometimes irregular and very much thickened, sparingly branched, uniform, tinged violaceous or ochraceous. *Spores* globose, faintly to strongly verrucose or spiny, 4-6.8  $\mu$ , tinted yellowish or bay brown, with dark epispore.

*Habitat* : solitary, on ground.

*Distribution* : South Africa ; North America ; Australia ; Canada ; Southern Europe ; New Zealand.

*Specimens examined* : Maclear, C.P., *P. J. Pienaar*, 2134, det. Wakefield ; Maputa, Mocambique, Aug. 1914, *Dr. Breijer*, 8361 ; Eagle's Nest, Bloemfontein, March 1917, *Geo. Potts* 7173, 13016 ; Pretoria, March 1925, *J. Wickens*, 20372, Nov. 1911, *P. J. Pienaar*, 1939, *A. O. D. Mogg*, 23640 ; Matatiele, C.P., *Gideon Joubert*, 26852 ; Stellenbosch, *Duthie* 40, 31312 ; Pietermaritzburg, Natal, Jan. 1915, *J. M. Sim*, 8796 ; Natal, *Medley Wood* 408, 11147 and Kew ; Donnybrook, Natal, *E. M. Doidge*, 34538 ; Stella Bush, Durban, July 1917, *P. v. d. Byl* 543 (N.H. 695) 31901, *Indian Collector* (N.H. 477) 31769 ; Riviera, Pretoria, May 1916, *L. Kresfelder*, 9795 ; Llandudno, C.P., *E. L. Stephens*, 34573 ; Kirstenbosch, *L. Bolus* (v. d. Byl 1669) det. Lloyd ; Rondebosch, C.P., *E. L. Stephens* 131 ; Kirstenbosch, *E. L. Stephens* 404 ; Cape Feninsula, *E. L. Stephens* 550, 565, 506.

*Specimens not seen* : near Boschberg, *MacOwan* 1004, 1009 ; Stella Bush, Durban, *Indian Collector*, 31769, Durban, *P. v. d. Byl*, 390, 391, 543 ; Stellenbosch Flats, *Duthie* 42, 121, 188 (v. d. Byl 816) ; Woodbourne, Knysna, *Duthie* 46, 116 ; edge of Rain Forest, Victoria Falls, S. Rhodesia, *Cheesman*.

This species is reported by Miss Stephens to be the commonest puff-ball in the South-western Cape Province. It is recognised by the purplish colour of the gleba, the persistent sterile base, which often remains attached to the substratum after the upper part has disintegrated and is often the only part collected, the large, verrucose spores and the very fragile nature of the mature plant. The diaphragm is not always easily distinguishable.

### 3. *Calvatia gigantea* (Batsch ex Persoon) Lloyd, [Plate XLIV, fig. 1.]

Mycological Writings 1, Mycological Notes 16 (1904) 166.

G. H. Cunningham, Gastero. (1944) 158.

*Lycoperdon giganteum* Batsch ex Pers. Syn. Meth. Fung. (1801) 140.

*Bovista gigantea* (Batsch ex Pers.) Nees, Syst. Pilze (1817) 34.

*Lycoperdon bovista* Fr., Syst. Myc. 3 (1829) 29.

*Calvatia maxima* (Schaeff.) Morg., Journ. Cin. Soc. Nat. Hist. 12 (1890) 166.

*C. bovista* Macbride, Bull. Lab. Nat. Hist. Univ. Iowa 4 (1896) 41.

*C. primitiva* Lloyd, Myc. Writ. 1, Lyc. Aus. (1905) 36.

"Peridium subglobose, to 40 cm. diam., sessile, with a strongly developed, cord-like basal rhizomorph, brown, thin, fragile, flaking away irregularly, exterior smooth, finely tomentose, resembling chamois leather, cream or yellowish, fugacious; sterile base scanty and poorly developed, compact, frequently wanting; diaphragm absent. Gleba yellowish, becoming olivaceous, semi-compact; capillitium threads long, sparingly branched, septate, olivaceous. Spores 4-6  $\mu$  diameter, episporous olivaceous, 0.75  $\mu$  thick, covered with a delicate, hyaline, gelatinous exospore, which often appears delicately verruculose; briefly pedicelled." (Description after Cunningham, l.c.)

*Habitat*: on ground on hills.

*Distribution*: South Africa; North America; Australia; Europe; India; New Zealand.

*South African Record*: outside Cape Town, Thunberg.

This species is distinguished by its large size, leathery peridium, verruculose spores and absence of a well-developed sterile base. No specimens have been available for examination.

#### 4. *Calvatia saccata* (Vahl ex Fries) Morgan,

North American Fungi, Journal Cincinnati Society of Natural History XII, p. 171.  
Sacc. Syll. Fung. 7 (1888) 128.

*Lycoperdon saccatum* Vahl., Fl. Dan. t. 1139; Kalchbrenner, Grev. 10 (1882) 108;  
Sacc. Syll. Fung. 7 (1888) 128.

Peridium 2.5-5 cm. wide, 7.5-12.5 cm. high, depressed globose, turbinate or abruptly narrowed into a stalk-like base; base thick, 2.5 cm. or thicker, stumpy, often pitted, attached by mycelial threads. *Eroperidium* very thin, consisting of erect spines or granules, which largely disappear. *Endoperidium* white or greyish, later brownish, very thin and fragile, at maturity breaking away from the upper portion in areolate fragments. *Gleba* persistent—a spongy, cotton wool-like mass. *Sterile base* present, large, occupying the stalk-like base. *Diaphragm* absent. *Capillitium* threads brownish-olivaceous, long, sparingly branched, thinner than, or seldom as thick as the spore diameter, branches thinner. *Spores* fuscous, warty or spiny when mature, 4-6  $\mu$  diam., often pedicellate; pedicels thin, hyaline, 10-16  $\mu$  long. (Description from two specimens ex Herb. Dr. L. Hollós.)

*Habitat*: on ground.

*Distribution*: South Africa; North America; Britain; Europe.

*South African Record*: in wooded country, near Somerset East, MacOwan.

This species is said to be a very variable plant with many varieties. MacOwan's specimens were not available for examination, therefore it is impossible to say if these are the same plant as that described above.

#### 5. *Calvatia lepidophora* (Ellis) Lloyd, [Plate XLII, fig. 2; XLIII.]

Mycological Writings 2, Notes to Index, No. 13 (1905-1908) 14.

Coker and Couch, Gastero. (1928) 60.

*Lycoperdon lepidophorum* Ell. et Everh., Myc. (1885) 88, non Peck.

*Bovista lepidophora* (Ell. et Everh.) de Toni, Sacc. Syll. Fung. 7 (1888) 1033.

*Calvatia pachyderma* Morgan.

*Hypoblema pachyderma* Lloyd, Myc. Writ. 1, Gen. Gaster. (1902) Pl. 11, fig. 49.

*Hypoblema lepidophora* Lloyd, Myc. Writ. 1, Myc. Notes 14 (1903) 140, Pl. 14.

*Peridium* epigeous, depressed globose or obovate, 4.5-13 cm. wide, 4.5-7 cm. high, sessile, with a thick, cordlike rooting structure. *Exoperidium* up to 1 mm. thick, firm, brittle, shell-like when dry, sometimes fairly smooth but usually rough, finely tubercular, or divided into large, flattened, wart-like areolae, white at first, finally dirty white or tan, caducous, splitting into sections which drop off, exposing the endoperidium. *Endoperidium* pale tan (Ochraceous Tawny, Sayal Brown, Tawny) thin, membranous, smooth to finely floccose, like kid leather to the touch, completely enclosing the compact gleba, finally breaking away. *Sterile base* wanting. *Gleba* greenish yellow, becoming brownish-olivaceous, pale tan or umber, forming a soft, spongy, compact mass, which remains intact for a long time, but finally disintegrates from the outside inwards, due to the fragmenting of the capillitium threads. *Capillitium* threads abundant, closely intertwined, long, thick-walled, septate, fragmenting, sparingly branched, usually at a wide angle, greenish yellow to pale olive brown, varying in thickness up to 10.2  $\mu$  diam. *Spores* globose, tinted greenish to umber, finely verruculose, 3.5-4.5  $\mu$  diam., often with a conspicuous central or excentric *gutta*.

*Habitat* : on sandy soil, usually solitary.

*Distribution* : South Africa; North America.

*Specimens examined* : Garstfontein, Pretoria, April 1911, P. J. Pienaar, 1468; Meintjes Kop, Pretoria, May 1920, I. B. Pole Evans, 13795; Rietfontein, Pretoria, April 1921, Venter, 14638; Matatiele, C.P., June 1935, Gideon Joubert, 28534.

This species is very near *C. macrogemmae* but is a larger plant and has a less warty exoperidium. It differs from *C. gigantea* mainly in texture and in having a thick, rough exoperidium. From *C. caelata* it differs in the lack of a sterile base and diaphragm and in having a compact gleba.

Specimens of No. 28534 were sent to Lloyd for identification and were originally named by him *Hypoblema lepidophora*. Later he decided that they were the same as *Calvatia lepidophora*.

#### 6. *Calvatia candida* (Rostkovius) Hollós, [Plate XLI, fig. 1.]

Termeszterajzi Füzetek 25 (1902) 112.

*Langemannia candida* Rostk., Sturm. Deutsch Krypt. Flora 3 (1837) 25.

*Bovista tunicata* Bon., Bot. Zeit. 15 (1857) 597.

*Lycoperdon candidum* (Rostk.) Bon., Sacc. Syll. Fung. 7 (1888) 483.

*Bovista olivacea* Cooke et Mass., Journ. Bot. 26 (1888) 133.

*Calvatia olivacea* (Cooke et Mass.) Lloyd, Myc. Writ. 1, Lyc. Aus. (1905) 37.

*Lycoperdon retis* Lloyd, Myc. Writ. 7, Myc. Notes 68 (1923) 1176.

*Peridium* up to 6 cm. high, 5.5 cm. wide, pyriform, usually narrowing abruptly to a thick, strongly rooting base, smooth above but often crenulate at base. *Exoperidium* greyish-brown, furfuraceous, fugacious. *Endoperidium* becoming very thin, papery, smooth warm brown (between Tawny and Sayal Brown) at maturity breaking away in segments

from the apical part, exposing the spongy, interwoven gleba, which resembles a ball of brown cotton wool. *Gleba* persistent, brown (nearest Tawny Olive) or pale brownish-olivaceous (nearest Old Gold and Isabella) soft and spongy, remaining compact until it disintegrates. *Sterile base* well developed, cellular, whitish at first, finally brown or olivaceous brown. *Diaphragm* absent. *Capillitium* threads abundant, closely interwoven, equal, up to size of spore diameter, but usually smaller, tinted to olivaceous brown, sparsely if septate, sparingly branched, sometimes punctate. *Spores* tinted, olivaceous or hyaline, yellow ochre in mass, globose,  $3\cdot4-5\ \mu$  diam., occasionally up to  $6\cdot8\ \mu$ , finely verrucose, often apiculate.

*Habitat* : on ground, solitary or caespitose.

*Distribution* : South Africa ; Australia ; Europe.

*Specimens examined* : under *Eucalyptus* trees, Pietermaritzburg, April 1911, *I. B. Pole Evans* (Lloyd Myc. Coll. 34259) 1342, Kew ; in bush, Bulwer, Natal, *W. G. Rump* 467, 34523 ; Pietermaritzburg, *J. M. Sim*, 10052, *W. G. Rump* 710, Rietfontein, Pretoria, *Venter*, 14638.

*Specimens not seen* : without locality, *Duthie* (Lloyd, Myc. Coll. 51765).

7. **Calvatia incerta** n. sp., [Plate XXXIX, 4th row.]

*Peridio* 3-7 cm. lato, 3-6 cm. alto, obovato, subgloboso, supra depresso, nitente, superne leve basi valide plicata, in humida tempestate rubro, pallescente celeriter vel in tempestate siccitate metallico badio, breve radicato. *Exoperidio* sicci fungi olivaceo, furfuraceo, evanescente vel in vetustate saepe squamulis albidis minimis persistente. *Endoperidio* rubro vel olivaceo-umbrino, leve tenui, fragili, membranaceo, in maturitate supra mox in fragmenta irregulariter dehiscente et decidente. *Gleba* umbrina vel olivacea, denum pulverulenta. *Basi* sterili absente. *Capillitio* subhyalino dein dilute olivaceo ; floccis densissimis, plerumque levibus aequabilibusque, undulatis, vix ramosis, ad septa secedentibus,  $3\cdot4-8\cdot5\ \mu$  diam. *Sporis* globosis, nonnunquam breviter pedicellatis,  $3-4\ \mu$  diam.

Hab. in locis graminosis apud pluviam multam, Benoni, leg. *L. Bailey*, 27339.

*Peridium* 3-7 cm. wide, 3-6 cm. high, obovate, subglobose, depressed at apex, shining, smooth above, strongly plicate at base ; fresh plants scarlet in wet weather, the red colour soon fading, metallic bay brown in dry weather ; attached by a short, thick rooting structure. *Exoperidium* of dry weather plant olivaceous, furfuraceous, disappearing, or often remaining as minute, whitish specks on old plants. *Endoperidium* scarlet or olivaceous-brown, depending on weather conditions, smooth, thin, very fragile, membranaceous, dehiscing by breaking away in irregular sections from the apical part. *Gleba* bay brown or olivaceous, pulverulent, soon disintegrating. *Sterile base* lacking. *Capillitium* threads sub-hyaline to pale olivaceous, abundant, fragmenting, usually smooth and uniform, wavy, occasionally branched,  $3\cdot4-8\cdot5\ \mu$  diam. *Spores* globose, sometimes shortly apiculate,  $3-4\ \mu$  diam.

*Habitat* : on grassy slopes after continuous rain.

*Distribution* : South Africa.

*Specimens examined* : Benoni, Tvl., Nov. 1933, *L. Bailey*, 27339.

From a photograph and description of the above plant, Dr. G. H. Cunningham was unable to connect it with any known species ; the specimen sent to him unfortunately did not reach its destination.

8. *Calvatia pachyderma* (Peck) Morgan. [Plate XLIV, fig. 2.]

Journal of the Cincinnati Society of Natural History (1889) 167.

Coker and Couch, Gastero. (1938) 60.

*Lycoperdon pachyderma* Peck, Bot. Gaz. 7 (1882) 54.

*Peridium* 7.5 cm. diam., subglobose, attached by a single, thick rooting structure, partly submerged in sand. *Exoperidium* dirty white, scanty, tomentose, mixed with sand, disappearing in patches, not separable from the endoperidium. *Endoperidium* fairly thick, up to 1 mm., hard, corky, dirty white or pale brown, smooth, persistent for a long time; dehiscence not seen but presumably by the breaking up of the apical part into segments. *Gleba* bright yellowish-olivaceous (between Sulphur Yellow, Honey Yellow and Isabella colour). *Sterile base* lacking. *Capillitium* threads almost hyaline to pale yellowish green, branched, septate, soon fragmenting, wavy, fairly uniform, thickness up to diameter of largest spores. *Spores* globose, concolorous or darker, finely verrucose, 4-6  $\mu$  diam.

*Habitat* : solitary, in sandy soil.

*Distribution* : South Africa; North and South America; Catalina Island.

*Specimen examined* : Cape Province, ? *E. L. Stephens*, 34143.

This plant is said to very much resemble *Mycenastrum corium* with its hard, thick, smooth, light-coloured peridium, but differs in having long, branched capillitium threads without spines.

The identification of the above specimen is not at all certain, as only one plant was available for examination. When this genus was studied, war conditions were such that it was impossible to send specimens to the United States for Dr. Coker's opinion.

9. *Calvatia macrogemmae* Lloyd.

Mycological Writings 7, Mycological Notes 68 (1922) 1122 and (1923) 1109.

Verwoerd, Ann. Univ. Stell. 3 (1925) 33.

*Peridium* epigeous, 5 cm. diam., depressed-globose. *Exoperidium* woody, consisting of large, thick, wart-like scales, which probably disappear with age. *Endoperidium* pale brown, thin, membranaceous, brittle, smooth. *Sterile base* lacking. *Gleba* olivaceous. *Capillitium* threads long, septate, branched, hyaline, 1.7-6.8  $\mu$  diam. *Spores* irregularly globose or ellipsoid, smooth, hyaline to tinted, 3.3-4.4  $\times$  4.4-5  $\mu$ . (Description translated from Verwoerd, l.c.)

*Habitat* : on ground amongst grass.

*Distribution* : South Africa.

*Specimens examined* : Natal, *J. Thode* (v. d. Byl 505).

*Specimens not seen* : without locality, *v. d. Byl* 80 (Lloyd Myc. Coll. 22585) Type.

4. **LANOPILA** Fries.

Fungi natalenses in K. Vetensk. Akad. Handligner, Stockholm (1848) 151.

Lloyd, Myc. Writ. 1, Myc. Notes 8 (1904) 190, Myc. Writ. 7 (1923) 1177; Verwoerd, Ann. Univ. Stell. 3 (1925) 24; Ed. Fisch., Nat. Pflanz. 7a (1933) 64.

Type Species : *Lanopila Wahlbergii* Fr.

Peridium superficial, sessile, more or less globose, becoming detached at maturity. Endoperidium thin, papery, brittle, finally dehiscing irregularly. Gleba a compact, elastic mass, consisting of long, intertwined capillitium threads and globose spores. Sterile base lacking.

This genus was proposed by Fries for a specimen sent to him from South Africa by Wahlberg. According to Lloyd, l.c., it differs from *Bovista* only in the capillitium, which in *Lanopila* consists of long interwoven threads and in *Bovista* of short, separate threads. On the other hand, there appears to be no strict dividing line between this species and those species of *Calvatia* in which the sterile base is lacking and the capillitium threads form a compact spongy mass.

#### Key to the Species.

Spores verrucose.....	1. <i>L. Wahlbergii</i> .
Spores smooth.	
Capillitium threads smooth.....	2. <i>L. Radloffiana</i> .
Capillitium threads punctate.....	3. <i>L. capensis</i> .

#### 1. *Lanopila Wahlbergii* Fr., [Plate XLV.]

*Fungi Natalenses* (1848) 151.

*Sacc. Syll. Fung.* 7 (1888) 95; Lloyd, *Myc. Writ.* 5, Letter 66 (1917) 8, Note 583, *Myc. Writ.* 7 (1923) 1177; Verwoerd, *Ann. Univ. Stell.* 3 (1925) 25.

*L. bicolor* (Lév.) Pat., *Champignons de la Guadeloupe*, *Bull. Soc. Myc. Fr.* 15 (1899) 191; *Sacc. Syll. Fung.* 16 (1902) 240; Lloyd, *Myc. Writ.* 1, Notes 18 (1904) 180.

*Bovista bicolor* Lév., *Ann. Sci. Nat. ser. 3, 5* (1846) 162; *Sacc. Syll. Fung.* 7 (1888) 102.

Peridium 6-6.5 cm. wide, 5-5.5 cm. high, depressed globose or subglobose, breaking away from its point of attachment at maturity. Exoperidium thin, smooth except for adherent grains of sand, fragile, membranaceous, falling away from the endoperidium in small pieces, brown (between Sayal Brown and Russet) firmly adherent to endoperidium. Endoperidium deep ochraceous or light buff (Clay to Light Buff) smooth, like kid leather to the touch, thin, fragile, membranaceous, long permanent, finally cracking into small areas which break away. Gleba compact, somewhat resembling cotton wool, floccose, greyish brown (Buffy Brown, Snuff Brown). Capillitium abundant, threads long, interwoven, branched, almost hyaline to deep olivaceous, smooth, sparsely septate, thickness variable, less than to greater than diameter of spores. Spores dark brown, globose, finely or strongly verrucose, 5-7  $\mu$  diam.

*Habitat*: solitary in sandy soil.

*Distribution*: South Africa; South America; Belgian Congo; Ceylon; Cuba; India; West Indies; Mexico.

*Specimens examined*: Durban, April 1919, *A. M. Bottomley*, 12254; near Mafeking, C.P., Sept. 1934, *I. B. Pole Evans*, 27500; Durban, *v. d. Byl* 314.

*Specimens not seen*: Durban, Wahlberg; Knysna, C.P., Duthie 241 as *L. bicolor*.

In specimen No. 27500, the brown exoperidium is present on the basal half, forming a distinct contrast with the light buff coloured upper half. Such a specimen well justifies Léveillé's specific name "bicolor".

#### 2. *Lanopila Radloffiana* Verwoerd.

*Annale Universiteit Stellenbosch* 3 (1925) 25.

Peridium 3 cm. diam., superficial, more or less globose, slightly pointed at the base. Sterile base wanting. Exoperidium single, smooth, more or less papery, pale amber, falling

away and exposing an amber coloured gleba. *Capillitium* threads long,  $1\cdot7$ – $3\cdot4$   $\mu$  diam., more or less hyaline, branched, intertwined and forming a homogeneous, elastic mass, septate, slightly enlarged at the septa, smooth. *Spores* globose, smooth, light coloured,  $3\cdot4$ – $3\cdot8$   $\mu$  diam. (Description translated from that of Verwoerd, l.c.)

*Habitat* : solitary in sandy soil.

*Distribution* : South Africa.

*Specimen examined* : Winburg, O.F.S., *Miss Radloff* (v. d. Byl 1439) *Type*.

This is the only collection on record.

### 3. *Lanopila capensis* Lloyd.

*Mycological Writings* 7, *Mycological Notes* 68 (1923) 1177.

Verwoerd, *Ann. Univ. Stell.* 3 (1925) 25.

*Peridium*  $3\cdot5$  cm. diam., superficial, more or less globose, with a small, sterile base. *Exoperidium* single, smooth, thin, papery, brown. *Gleba* dark brown. *Capillitium* threads long, up to  $7\cdot2$   $\mu$  diam., brownish-olivaceous, usually finely punctate and with a watered appearance, septate but fragmenting at the septa, sparsely branched. *Spores*  $3\cdot4$ – $4\cdot5$   $\mu$  diam., globose, often with a short pedicel, almost hyaline to light brownish-olivaceous with a dark wall, smooth or subtly verruculose, usually with one large central or excentric dark bordered vacuole. (Description ex Verwoerd, l.c.)

*Habitat* : Solitary, in sandy soil.

*Distribution* : South Africa.

*Specimen examined* : Papegaaisberg, Stellenbosch, C.P., June 1921, *Duthie* 304, 31472, part of *Type* (Lloyd Myc. Coll. 7567, *Type*).

The species is recognised by the punctate, watered appearance of the capillitium threads.

### BOVISTA Dilleniæ ex Persoon.

*Synopsis Methodica Fungorum* (1801) 136.

*Globaria* Quel., *Mém. Soc. Emulat. de Montbéliard* 2 Sér. 5 (1871–75) 370.

*Sackeu* Rostk., in *Sturm, Deutschl. Flora*, III Abt., 5 (1839) 33.

*Bovistella* Morgan, *Journ. Cincinnati Soc. Nat. Hist.* 14 (1892) 145.

Type Species : *Bovista plumbea* Pers.

Plants globose, subglobose or pyriform, provided or not with a well-developed rooting base, becoming detached or not from the substratum at maturity. *Exoperidium* thin, fragile, partially or entirely disappearing at maturity. *Endoperidium* thin, firm, often metallic-looking, smooth or finely warted, dehiscing by an apical pore. Sterile base present or absent. *Capillitium* of free threads, each consisting of a thick stem which branches dichotomously or irregularly into thinner, acuminate branches. *Spores* coloured, globose, obovate or elliptical, smooth or rough, pedicellate or not.

The characteristic feature of this genus is the capillitium threads, which consist of a thick stem with usually dichotomous branches.

In his recent work on the Gasteromycetes (1944) 142 Cunningham rejects the genus *Bovistella* on the grounds that collections of *Bovista brunnea* and *Bovistella bovistoides*

examined by him could be placed under either genus, since plants in the same collection may be with or without a rooting base and growing attached or free. He therefore sinks Morgan's genus *Bovistella* under *Bovista* Dill. ex. Pers. Cunningham's arrangement is followed here.

**Key to the Species.**

Spores broadly oval, $4 \times 6 \mu$ .....	1. <b>B. oblongispora.</b>
Spores globose, $3-5.2 \mu$ .	
Endoperidium yellow.....	2. <b>B. citrina.</b>
Endoperidium brown.....	3. <b>B. umbrina.</b>

**1. Bovista oblongispora** (Lloyd) n. comb.

*Bovistella oblongispora* Lloyd, Myc. Writ. 5, Myc. Notes 45 (1917) 632; Verwoerd, Ann. Univ. Stell. 3 (1925) 29.

*Peridium* 1-2 cm. diam, subglobose. *Exoperidium* furfuraceous. *Endoperidium* thin. *Gleba* compact, olive then umber. *Sterile base* wanting. *Capillitium* threads deep coloured, long, intertwined, much branched, about  $3 \mu$  diam. *Spores*  $4 \times 6 \mu$ , oblong, deep coloured, smooth, with a short, thick, permanent, subhyaline pedicel,  $4-5 \mu$  long. (Description ex Lloyd, l.c.).

*Habitat*: on ground.

*Distribution*: South Africa.

*South African Record*: Belvidere, Knysna, *Duthie* 99 (Lloyd Myc. Coll. 30756, *Type*). No specimen was lodged in any South African Herbarium.

**2. Bovista citrina** (Berkeley & Broome) n. comb.

*Lycoperdon citrinum* Berk. & Broome, Journ. Linn. Soc. 14 (1873) 80.

*Bovistella citrina* (Berk. & Br.) Lloyd in Petch, Ann. Roy. Bot. Gard., Peradeniya 7 (1919) 71.

*Peridium* up to 4 cm. diam., globose or depressed globose, sometimes lacunose below, usually arising from a stout, cord-like mycelium. *Exoperidium* delicate, of minute white spines or warts, which may disappear or persist in the form of minute warts. *Endoperidium* becoming thin and papery, lemon yellow, pale towards base; old specimens dark red-brown when moist, drying to dark shining olive, covered with minute, deep red-brown, or almost black warts. *Gleba* olive. *Sterile base* wanting. *Capillitium* threads yellow-brown, stout, thick-walled,  $3-10 \mu$  diam., branching usually at a wide angle, with occasional septa above the forks. *Spores* globose,  $3-4 \mu$  diam., pale olive, very minutely echinulate, with hyaline pedicels up to  $16 \mu$  long.

*Habitat*: on ground.

*Distribution*: Ceylon; South Africa.

*South African specimens*: Salisbury, S. Rhodesia, *Eyles* 7219, 7221, Kew.

This species is characterised by the lemon yellow colour of the endoperidium of the growing plant and the inconspicuous, very delicate exoperidium of minute white spines or warts.

**3. Bovista umbrina** n. sp.

*Peridio* subgloboso 2.5-3 cm. diam., basi valde radiciformi, 1-1.5 cm. diam. praedito. *Exoperidio* umbrino, in siccitate fere toto evanescente vel minimis floccis squamulis in depressionibus obscuris persistente. *Endoperidio* umbrino, plumbeo-purpureo tineto,

tenui, levi, ostiolo lacero, usque 6 mm. diam. dehiscenti, basi sterili nulla. *Gleba* purpureo-umbrina. *Capillitio* e filamentis pallide usque valde brunneis, plus minusve dichotomis-ramosis, levis, 2-10.2  $\mu$  diam. formatu. *Sporis* globosis, late ellipsoidis v. obovatis umbrinis, levis vel obscure verruculosis, 3-5.2  $\mu$  diam., pedicellatis, pedicellis tenuibus, obscure coloratis, usque ad 18.7  $\mu$  longis.

Hab. in sylvis, Woodbush, Zoutpansberg, leg. *Noel Roberts*, 5659.

*Peridium* subglobose, 2.5-3 cm. diam., attached by a well-developed, subglobose to obconical rooting base 1-1.5 cm. diam. *Exoperidium* umber brown, either disappearing entirely or persisting as minute, floccose scales seated in small, closely set, areolate depressions hardly visible to the naked eye. *Endoperidium* between Bone Brown and Fuscous, with a purplish metallic sheen, thin, smooth to faintly pitted, dehiscing by an irregular torn mouth, up to 6 mm. across. *Sterile base* absent. *Gleba* chocolate brown with a purplish tinge (nearest Mars Brown). *Capillitium* threads pale to dark bay brown, sparsely to freely branched, smooth, thick-walled, 2-10.2  $\mu$  diam. *Spores* globose, broadly oval or obovate, dark brown, 1-vacuolate, smooth or obscurely verruculose, 3-5.2  $\mu$  diam., pedicellate. Pedicels tinted, slender, slightly acuminate, long, up to 18.7  $\mu$ .

*Habitat* : in forest.

*Distribution* : South Africa.

*Specimens examined* : Woodbush, Zoutpansberg, Tvl., Jan. 1913, *Rev. N. Roberts*, 5659.

I am indebted to Mr. P. H. B. Talbot for comparing this species with other *Bovista* species at Kew and for the following note:—"In colour this species is near *B. plumbea*, *B. nigrescens*, *B. ovalispora* and *B. brunnea* but is distinct from all these by the possession of a finely warted peridium and by spores with longer and stouter pedicels apart from any other considerations. Kew has no specimens of *B. purpurea* which, by its description in Cunningham's 'Gasteromycetes of Australia and New Zealand' is close to No. 5659, but possesses a smooth peridium." On Miss Wakefield's suggestion, the South African plant has been described as a new species.

### MYCENASTRUM Desvaux.

*Annales des Sciences Naturelles* Sér. II, 17 (1842) 143.

*Endoneuron* Czern., *Bull. Soc. Imp. Nat.*, Moscou 18 (1845) 151.

*Pachyderma* Schulz, *Verh. Zool. Bot. Ges. Wien* 25 (1875) 79.

Type Species : *Mycenastrum corium* (Guers.) Desv.

Peridium subglobose, obovate or irregular when caespitose, up to 20 cm. across; outer wall consisting of two layers, a thin, floccose, deciduous exoperidium and a thick, hard, sub-woody endoperidium which dehisces in a stellate manner or by the breaking away of portions of the upper parts of the plant; attached to the ground by a thick root-like structure from which it soon becomes detached. Gleba greenish yellow, olivaceous, finally umber, pulverulent. Capillitium threads coarse, abundant, short with acuminate pointed ends, branched, non-septate, all parts covered with short, spiny processes. Spores globose or broadly elliptical, brown, nearly smooth to coarsely echinulate.

This genus contains a single cosmopolitan species, of which the original plant came from France and was named *Lycoperdon corium* by Guersent in 1815. The plant very much resembles a *Scleroderma* in outward appearance and has often been mistaken for it, but the characteristic spiny capillitium serves to distinguish it from this genus. Other distinguishing features are the sub-woody endoperidium and the method of dehiscence.

**Mycenastrum corium** (Guersent ex D.C.) Desvaux, [Plate LXV.]

Annales des Sciences Naturelles, Sér. II, 17 (1842) 147.

Berkeley, Hook. Lond. Journ. Bot. 2 (1843) 418; Verwoerd, Ann. Univ. Stell. 3 (1925) 26; G. H. Cunningham, Gastero. (1944) 135.

*Lycoperdon corium* Guers., D.C., Fl. Fr. suppl. 2 (1815) 598.

*Bovista suberosa* Fr., Syst. Myc. 3 (1829) 26.

*Scleroderma corium* Grev., Duby, Bot. Gall. 2 (1830) 892.

*Mycenastrum phaeotrichum* Berk., Hook. Journ. Bot. 2 (1843) 418.

*M. chilense* Mont., Ann. Sci. Nat., Ser. 2, 20 (1843) 375.

*Endoneuron suberosum* Czern., Bull. Soc. Imp. Moscou 18 (1845) 152.

*Sterebeckia Geaster* Fr., Fung. nat. (1848) 30.

*Mycenastrum leptodermeum* Dur., Fl. Alg. (1849) 386.

*M. radicum* Dur., l.c., p. 387.

*M. Beccarii* Pass., Nuov. Giorn. 7 (1875) 183.

*Pachyderma Strossmayeri* Schulz, Verh. Zool. Bot. Ges., Wien, 25 (1875) 79.

*Mycenastrum clausum* Schulz, Mycol. Beitr., Zool. Bot. Ges. Wien 27 (1877) 114.

*Bovista spinulosa* Peck, Bot. Gaz. 3 (1879) 170.

*Mycenastrum spinulosum* Peck, 33rd Rept., Bot. Gaz. 6 (1883) 240.

*M. olivaceum* Cooke et Massee, Grev. 16 (1887) 33.

*Scleroderma phaeotrichum* (Berk.) de Toni, Sacc. Syll. Fung. 7 (1888) 139.

*S. chilense* (Mont.) de Toni, Sacc. Syll. Fung. 7 (1888) 139.

*S. spinulosum* (Peck) de Toni, Sacc. Syll. Fung. 7 (1888) 141.

*S. radicum* (Dur.) de Toni, Sacc. Syll. Fung. 7 (1888) 141.

*S. leptodermeum* (Dur. et Mont.) de Toni, Sacc. Syll. Fung. 7 (1888) 141.

*S. Beccarii* (Pass.) de Toni, Sacc. Syll. Fung. 7 (1888) 142.

*S. olivaceum* (Cooke et Mass.) de Toni, Sacc. Syll. Fung. 7 (1888) 142.

*Peridium* globose, subglobose, obovate or irregular when caespitose, often plicate at the base, up to 14 cm. across unexpanded, 20 cm. expanded, attached by a thick, rootlike structure, from which it soon breaks away and tumbles in the manner of a *Bovista*. *Exoperidium* whitish, floccose, slowly fugacious. *Endoperidium* 2-5 mm. thick, smooth, greyish or parchment colour, finally umber brown, at maturity usually splitting from the apex downwards into unequal rays, the apices of which usually bend back and often become recurved, or breaking away in pieces from the upper portion. *Gleba* without sterile base, greenish-yellow, becoming olivaceous then umber, pulverulent but remaining intact for some time after expansion of the endoperidium. *Capillitium* threads abundant, thick, up to at least 14  $\mu$  diam, hyaline to yellow-olivaceous or olive brown, short, pointed at the ends, sparsely to freely short-branched, sometimes in a dichotomous manner, all parts, but especially the ends, thickly, or only occasionally covered with short, thorn-like, simple or branched spines. In immature specimens, the capillitium is mixed with trama remains and hyaline to brown, simple or branched hyphae which occur singly or in strands. *Spores* globose or broadly oval, 10.2-13.6  $\mu$ , dark brown or lighter, with a thick, dark wall, almost smooth to coarsely echinulate-reticulate.

*Habitat* : on the ground, occurring singly, in small groups or caespitose

*Distribution* : South Africa; North America; Asia; Australia; Europe; India; New Zealand.

*Specimens examined* : near Platrvier, Pretoria Distr., Nov. 1913, *P. J. Pienaar*, 9305; Burghersdorp, April 1916, *Gideon Joubert*, 9687; Sevenfontein, nr. Swellendam, *I. B. Pole Evans*, 12178; Pretoria, *I. B. Pole Evans*, 12899; Irene, May 1927, *I. B. Pole Evans*, 21927; near Grahamstown, Nov. 1929, *Hewitt*, 24899; Marikana, Rustenburg Distr., Tvl., March 1932, *A. M. Bottomley*, 26638; nr. Heidelberg, Tvl., May 1937, *J. M. Murray*, 28819; Port Elizabeth, Dec. 1936, *E. Haslem*, 28863; Brenton, Knysna, *A. V. Duthie* 319, 31484, 321 (v. d. Byl 1089), 31503; banks of Limpopo River, west of Messina, *I. B. Pole Evans*, 33244; Huisrivierberg, CP., Jan. 1923, v. d. Byl 1071 as *Myriostoma coliformis*; Stellenbosch, *D. Loseby* (E.L.S. 84).

*Specimens not seen* : nr. Uitenhage, *Zeyher* 90; on ground, Durban, *Wahlberg*; Ermelo, *Brink* (v. d. Byl 1094); Clanwilliam, *Duthie* 166; Brandfort, *Verwoerd* (Stell. 224; v. d. Byl 2080); Wolmaransstad, *Niewoudt* (Stell. 565).

## 7. BROOMEIA BERKELEY.

Hooker's London Journal of Botany 3 (1844) 193.

Sacc. Syll. Fung. 7 (1888) 94; Pole Evans and Bottomley, Trans. Roy. Soc. S. Africa 7, pt. 3 (1919) 189; Murray, Journ. Linn. Soc. 20 (1884) 311; Fischer, Nat. Pflanz. 7a (1933) 68; Lloyd, Myc. Writ. 6 (1920) 917; Verwoerd, Ann. Univ. Stell. 3 (1925) 34.

Fruiting bodies in clusters, few to numerous, closely aggregated together on a corky stroma, the upper surface of which is divided into alveolae, in each of which is embedded a single peridium, the walls of an alveola forming shallow upright ridges between the individual peridia. Peridia originally covered by a universal exoperidium, which gradually disintegrates, finally disappearing altogether. Endoperidium thin, membranaceous, sessile, dehiscing by a conical, fimbriate mouth.

The genus *Broomeia* is known only from Southern Africa, where it was first collected by J. Backhouse in 1838 in the Albany district and described by Berkeley in 1944, being named in honour of the botanist, C. E. Broome. Only two authentic species of this genus are known, viz. *B. congregata* Berk., the type species and *B. ellipsospora* v. Höhn. A third species, *B. guadaloupensis* Lév. from Guadalupe, of which no specimen exists, is said to be almost certainly *Diplocystis Wrightii* Berk. & Curt., which also occurs in Guadalupe.

### Key to the Species.

Stroma thick, columnar. Spores globose..... 1. ***B. congregata*.**

Stroma thin, horizontal, with edge incurved over the outer row of peridia, forming a margin round the cluster.

Spores elliptical..... 2. ***B. ellipsospora*.**

### 1. *Broomeia congregata* Berkeley, [Plate XLVI; XLVII, fig. 1, 2; XLVIII, fig. 2.]

Hooker's London Journ. Bot. 3 (1944) 193.

Murray, Journ. Linn. Soc. 20 (1884) 311; Sacc. Syll. Fung. 7 (1888) 93; Lloyd, Myc. Writ. 1, Myc. Notes 18 (1904) 193; Pole Evans & Bottomley, Trans. Roy. Soc. S. Africa 7, Pt. 3 (1919) 191; Verwoerd, Ann. Univ. Stell. 3 (1925) 34; Fischer, Nat. Pflanz. 7a (1933) 68.

Fruiting bodies in irregular clusters, 3-17 cm. diam., 1.5-10 cm. thick, consisting of 8 to over 900 peridia closely aggregated together on the surface of a massive, white, more or less columnar, wedge-shaped or irregular corky stroma. Surface of stroma divided into roundish or usually more or less pentagonal alveolae up to 15 mm. diam., in which the

peridia are embedded one sixth to a quarter of their height, the raised walls of the alveolae, 1·3 mm. high forming common dividing ridges between the individual peridia. The whole cluster of peridia is originally covered by a thin, white, membranaceous *exoperidium*, which appears to arise from the stroma at the base of the outer row of peridia and often to follow the outline of the individual peridia, extending between them as a floccose substance. Disintegration of the exoperidium takes place from the centre of the cluster towards the periphery, exposing first the mouths, then the remainder of the peridia. Mature plants are completely devoid of the exoperidium. *Stroma* solid, corky, more or less flattened or dome shaped at the apex, white except towards the base of the peridia, where it is tinged with mauvy pink. The core of the stroma sometimes breaks away, leaving an irregular hollow base. *Endoperidium* in young stage mauvy pink (Russet Vinaceous then Vinaceous Russet) finally dark brown (Cinnamon Brown, Mars Brown) sometimes whitish, due to the remains of the exoperidium; subglobose, ovate, turbinate, or, when tightly packed, angular, obovate, usually longer than wide, but occasionally wider than long; size varying from  $15 \times 12$  mm. to  $6 \times 3$  mm. or  $7 \times 9$  mm., sessile, embedded in base of alveolae; dehiscing by a round or elliptical, dark, fimbriate mouth which is seated on a slightly depressed area. *Gleba* brown to umber (Verona Brown, Warm Sepia) usually completely filling the endoperidium. *Columella* lacking. *Capillitium* almost hyaline to dark brown, varying in thickness up to more than diameter of spores, sparsely if at all septate, sparingly branched, almost smooth and regular or wavy, irregularly angled and thickened or nodulose. Spores finely to strongly echinulate, globose to rounded elliptic,  $6\cdot8-8\cdot5 \times 5\cdot1-6\cdot8 \mu$ . Common size  $6-7 \mu$ .

*Habitat*: often either on, or in close proximity to the base of living *Acacia* trees. Such trees often show gumming, but the association is not clear. Also found under other trees and occasionally on cattle manure. The fungus can often be detected by its characteristic smell, said to resemble aniseed.

*Distribution*: South Africa.

*Specimens examined*: on trunk of *Acacia karroo*, Groenkloof, Pretoria, Dec. 1914, *I. B. Pole Evans*, 8760; under *Acacia Karroo*, Pretoria, Dec. 1914, *Bischoff*, 8758, *A. J. T. Janse*, 13023, Feb. 1935, *B. Louwrens*, 28256, Feb. 1936, *A. M. Bottomley*, 28655; *Macranduli* Distr., Transkei, 1900, *A. Pegler* 643, 11801; under trees, Kimberley, July 1921, *C. M. Bray*, 14863; *Meintjes Kop*, Pretoria, July 1925, *L. Goldblatt*, 20441; in wattle plantation, Maritzburg, *T. R. Sim*, April 1919, 11855; in poplar bush, Potchefstroom, Tvl., Aug. 1933, *A. P. Goossens*, 27807; on cattle manure, Kroonstad, May 1929, *J. W. Pont*, 25341; habitat unknown, Mangwendi, S. Rhodesia, *Mrs. Flemming* (Eyles 2763) 14254; Glen, O.F.S., July 1935, *J. Sellschop*, 28272; Rietvlei, nr. Pretoria, May 1939, *J. P. H. Acocks*, 30754; Empangeni, Natal, April 1922, *H. H. Curson*, 17275; on soil, Rust der Winter, Warmbaths, 1936, *I. B. Pole Evans*, 28722.

*Specimens not seen*: Boschberg, C.P., 1876, *MacOwan* (S.A.M. 35073); Albany Distr., *Backhouse*, 1838, *Type*; S.W. Africa, *Dinter*; Umtata, *A. Pegler* (E. L. Stepkens 454 ex. Dr. Kolbe's Herb.); under *Acacia* trees, banks of Klein Vis Rivier, nr. Somerset East, *MacOwan*, Kew; habitat not known, Inanda, Natal, *Medley Wood* 426, ex. herb. M. C. Cooke, Kew; Durban, *Medley Wood*; Port Elizabeth, ex herb. Hooker, Kew; Damaraland, *Capt. Een*, 1879, Brit. Mus. and Herb. Kew; without locality, *E. L. Stepkens* 174, 454.

## 2. *Broomeia ellipsospora* v. Höhnel, [Plate XLVII, fig. 3, 4;

*Oesterr. bot. Zeitschr.* (1905) 99.

*Lloyd*, *Myc. Writ.* 6 (1920) 918, (1921) 1048; *Sacc. Syll. Fung.* 21 (1915) 479

*Verwoerd*, *Ann. Univ. Stell.* 3 (1925) 34.

*Diplocystis Junodii* *Pole Evans & Bottomley*, *Trans. Roy. Soc. S. Africa* 7 (1919) 189.

Fruiting bodies in more or less round or irregular clusters, 2-7 cm. long by 1-5 cm. wide by 2-3 cm. thick, sub-hygroscopic, swelling considerably when wet, no rooting structure seen, the whole under surface resting on top of the soil when found; consisting of few to many peridia (4-80 counted) closely aggregated together on a thin, cinnamon brown, sub-woody to punky, saucer-shaped stroma, the edge of which is erect, acute, toothed and incurved over the outer row of peridia, forming a permanent margin around the cluster. Upper surface of stroma divided into sub-globose or pentagonal walled alveolae, each containing a single peridium. Peridia separated from each other by the common alveolar walls, which are up to 5 mm. high, often dentate and on a level with the edge of the stroma. Under surface of stroma with rounded protruberances caused by the sunken bases of the alveolae in the upper surface, originally invested with a thin, pale smoke grey or brown cortical layer, which breaks away near the base of the turned-up edge, exposing the cinnamon brown (Mikado Brown) obscurely floccose, corky, inner layer. In some cases two layers appear to be present. *Exoperidium*: no young plant seen, but the appearance of several mature specimens in which fragments of tissue remain, indicate that this is white, membranous, and, in the young plant, covers the entire cluster of peridia, finally disappearing completely. *Endoperidium* slightly but firmly embedded in the base of the alveola, sub-globose or oval, sessile, slightly scabrous or finely floccose, grey or brown, with a conical, sharp-pointed, fimbriate, usually darker-coloured peristome, which is either continuous with the rest of the peridium, or seated on a slightly depressed, lighter coloured ring. *Capillitium* threads abundant, thin to size of longer diameter of the spore, fairly uniform, wavy, smooth to nodulose, occasionally branched, not or seldom septate, hyaline to pale brown. Spores pale brown with dark episporule, elliptical, occasionally sub-globose or boat-shaped, smooth; punctate and rough,  $6-8.5 \times 3.5-5 \mu$ .

*Habitat*: on sand or sandy soil.

*Distribution*: South Africa.

*Specimens examined*: Lourenço Marques, Moçambique, *H. Junod*, 11012, *Borle*, Aug. 1920, 14109; Rikatli, Moçambique, 1917, *H. Junod*, 23194, May 1919, *H. Junod*, 12169; Silikats Nek, Magaliesberg, May 1933, *H. Schweickerdt*, 26700; Potgietersrust, April 1940, *E. de Villiers*, 31287; Middelburg, Tvl., *R. A. Dyer*, 30503; between Dealesville and Hertzogville, O.F.S., Aug. 1944, *V. C. Green*, 34355; ? South-West Africa, *R. Marloth*, 26617; Brandberg Mts., N.E. of Cape Cross, S.W.A., Jan. 1933, *N. J. G. Smith* 401, 27510, found growing next to *Welwitschia* plants under extreme drought conditions; near Kimberley *J. H. Power* (E. L. Stephens 403); 20 miles s.w. of Marienthal, S.W.A., *R. H. M. Smithers* (E. L. Stephens 412; S.A.M. 52051).

*Specimens not seen*: South Africa, without locality, *Holub*, *Type*; Upington, *Miss Wilman* (E. L. Stephens 567).

*Diplocystis*, the genus nearest to Broomeia and not known to occur in South Africa, is represented by but one authentic species, viz. *D. Wrightii* Berk. et Curt. (Plate XLVIII, fig. 1). It differs from Broomeia mainly in having a separate exoperidium to each individual peridium instead of a universal one to the whole cluster, in the separation of the peridia by individual cup-like exoperidial structures instead of by alveolar ridges common to adjacent peridia, and in having an indefinite aperture instead of a well-defined conical mouth.

At the time *Diplocystis Junodii* was described as a new species of this genus (l.c.) no specimen or illustration of either *D. Wrightii* Berk. & Curt. (Plate XLVIII, fig. 1) or of *Broomeia ellipsospora* v. Höhn. had been seen. Although it was suggested that, judging from the description, our fungus might be the same as the latter, the thin stroma with its persistent turned-up edge differed so considerably from the massive, irregular stroma of *Broomeia congregata* that this character seemed sufficiently important to justify excluding it from *Broomeia* and referring it to *Diplocystis*. The importance of the exoperidial characters was not realised until the late C. G. Lloyd forwarded specimens of *D. Wrightii*,

making possible a comparison of the latter with *B. congregata* and ' *D. Junodii*'. Lloyd pointed out, at the time of sending the specimens, that the latter was the same as von Höhnel's *B. ellipsospora*, and after seeing specimens of *D. Wrightii* and an illustration of *B. ellipsospora*, there was no doubt about the matter.

In the paper cited, *Diplocystis* was separated from *Broomeia* on the stroma characters, but after having examined specimens of *D. Wrightii*, I am of the opinion that the exoperidial characters are of more importance, and have therefore reverted to these as a basis of demarcation between the two genera. *B. congregata* and *B. ellipsospora* are very divergent species, but have more affinity for each other than either has for *D. Wrightii*.

I have followed Fischer (Nat. Pflanz. 7a, 1933 : 68) and Coker and Couch (Gestero. 1928 : 143) in placing the genera *Broomeia* and *Diplocystis* in the Lycoperdaceae. The original structure of the gleba yet remains to be determined, but the presence of tramal remains suggests the original presence of chambers.

#### Geastreæ.

Peridium of four layers, the outer three closely adnate and splitting from the apex downwards in a stellate manner into a number of pointed segments or rays, exposing the globose or subglobose inner peridium, which dehisces by one or more apical pores. As in the case of *Lycoperdon*, the inner peridium encloses the capillitium threads which are attached to its inner wall, or to a small columella, when present, and the globose, usually verrucose spores.

There are only two genera in the Geastreæ, *Geastrum* and *Myriostoma*, both of which are represented in Southern Africa. *Myriostoma* differs from *Geastrum* in dehiscing by several mouths instead of one and in having several pedicels and columellas instead of one of each (when present) as in *Geastrum*.

#### 8. GEASTRUM Persoon.

Syncpsis Methodica Fungorum (1801) 131.

*Plecostoma* Desv., Journ. de Bot. 2 (1809) 97.

*Diploderma* Link, Mag. Ges. Nat. Freunde 7 (1816) 44 pp.

*Geaster* Micheli ex Fries, Syst. Myc. 3 (1829) 8.

*Cycloderma* Klotsch, Linnaea 8 (1832) 203.

*Astraeus* Morgan, Journ. Cincinnati Soc. Nat. Hist. 12 (1889) 19.

*Myceliostroma* P. Henn., Hedwigia 43 (1904) 185.

Type Species: *Geastrum coronatum* pers.

Unexpanded plant globose, subglobose or ovate with a short or long point. Exoperidium hygroscopic or not, consisting of three layers—an external or mycelial layer, a middle or fibrous layer and an inner or fleshy layer—at first closely surrounding the inner or endoperidium, but at maturity splitting from the apex downwards, to about the middle, into a number of pointed segments or rays. The rays may become expanded to form a star-shaped structure from which the genus derives its name, or they may become recurved. In one section of plants with recurved rays, the fleshy and fibrous layers separate from the mycelial layer and, remaining attached only at the tips, become arched above it, leaving it behind in the substratum as a membranaceous cuplike structure. Such a condition is known as fornicate. The inner peridium is globose to subglobose, thin, membranaceous, smooth or variously roughened, stalked or sessile and dehisces by a single apical mouth. The latter may be little more than a torn aperture, when it is said to be indefinite, or it

may be fimbriate, fibrillose or furrowed (sulcate) on a definite, usually circular area or peristome, outlined or not by a margin. In some species there is a circular swelling at the base of the endoperidium, just above the pedicel, known as an apophysis. The gleba, contained in the endoperidium consists of simple, non-septate, pale to dark brown capillitium threads and globose, obscurely to strongly verrucose, brown spores.

Many species of geasters have been described, but it is believed that not more than about eighteen are found in Southern Africa.

Cunningham, Coker and Couch and others have been followed in classifying the species of *Geastrum* on mouth characters.

#### Key to the Species.

Mouth with a peristome.

Mouth sulcate;

Exoperidium not hygroscopic

Pedicel and mouth typically long and slender

Base of endoperidium smooth, striate or plicate; plants usually large.....

1. *G. pectinatum*.

Base of peridium with a collar-like ring or apophysis.....

2. *G. Bryanti*.

Pedicel and mouth typically short, plants small.....

3. *G. nanum*.

Exoperidium hygroscopic.

Endoperidium pedicellate.....

4. *G. campestre*.

Endoperidium typically sessile.....

5. *G. ambiguum*.

Mouth fibrillose;

Exoperidium not hygroscopic

Endoperidium pedicellate

Exoperidium typically fornicate

Mouth fibrillose-fimbriate with depressed circular margin.....

6. *G. quadrifidum*.

Mouth coarsely fibrillose to sulcate without circular depressed margin.....

7. *G. dissimile*.

Exoperidium typically recurved or expanded

Plants usually small.....

8. *G. minimum*.

Plants usually large.....

9. *G. limbatum*.

Endoperidium sessile;

Exoperidium externally more or less glabrous, rays typically acuminate; plants and spores typically large.....

10. *G. triplex*.

Exoperidium externally usually felted or strigose-tomentose, rays typically wedge-shaped.

Exoperidium typically fully expanded, tips often reflexed.....

11. *G. saccatum*.

Exoperidium deeply saccate, tips often sub-erect.

Plants small, often caespitose; exoperidium light coloured.....

12. *G. mirabile*.

Plants medium, exoperidium dark.....

13. *G. velutinum*.

Exoperidium hygroscopic

Endoperidium pedicellate.....

14. *G. arenarium*.

Endoperidium sessile.....

15. *G. mammosum*.

Mouth without a peristome.

Exoperidium not hygroscopic

Endoperidium pedicellate

Exoperidium fornicate, endoperidium smooth.....

16. *G. fornicatum*.

Exoperidium recurved, endoperidium asperate.....

17. *G. Hieronymi*.

Exoperidium hygroscopic

Spores 6-7  $\mu$ ; plants usually small.....

18. *G. floriforme*.

Spores 8-10  $\mu$ ; plants usually large and woody.....

19. *G. hygrometricum*.

1. *Geastrum pectinatum* Persoon, [Plate XLIX, fig. 1-4.]

Synopsis Methodica Fungorum (1801) 132.

Lloyd, Geastreeae in Myc. Writ. 1 (1902) 15; Hollós, Gastero. Ung. (1904) 55, 152; G. H. Cunn., Gastero. (1944) 162.

*Geaster plicatus* Berk., Ann. Nat. Hist. 3 (1839) 339.

*G. tenuipes* Berk. in Hook. Journ. Bot. 12 (1848) 576.

*G. calyculatus* Fuckel, Symb. Myc. (1869) 37.

*G. Schmidelii* Massee, Monogr. Brit. Gastero. in Annals Bot. 4 (1889) 78, non Vittadini.

Unexpanded plant subglobose, submerged then superficial, ochraceous, covered with adhering debris. *Exoperidium* 2-5.5 cm. diam., split to about the middle into 6-10 subequal, acute rays, which are typically recurved, but may be more or less expanded with incurved tips; *fleshy layer* thin, ochraceous-brown, greyish-brown, chestnut, umber, adnate and continuous or cracking irregularly and peeling off in patches exposing the ochraceous fibrous layer, sometimes leaving the latter quite bare; *mycelial layer* adnate, covered with adhering debris, which is usually persistent. *Base* concave to vaulted. *Endoperidium* 0.7-1.8 cm. diam., pedicellate, subglobose, depressed globose or urn-shaped, greyish brown, pale reddish brown, dove-grey, rusty-black; smooth, striate or slightly to deeply sulcate at the base; furrows at base and mouth often covered at first with ochraceous-brown, woolly tomentum; with or without an apophysis; often farinose; pedicel typically long and slender (up to 5 mm.) often surrounded by a collar—the remains of the mycelial layer, which breaks away on expansion. *Mouth* typically long (up to 1 cm.) beaked, slender, deeply sulcate, concolorous or paler or darker than the remainder of the endoperidium, seated upon a definite, circular, depressed peristome, of which the margin is sometimes raised. *Columella* not seen. *Gleba* umber brown. *Capillitium* threads sometimes branched, tinted to pale brown, thicker and paler than average spore. *Spores* dark brown, globose, strongly verrucose, 3.5-5.1  $\mu$  diam.

*Habitat*: solitary or gregarious, amongst humus.

*Distribution*: South Africa; Australia; Ceylon; India; Tasmania; New Zealand.

*Specimens examined*: Fountains, Pretoria, Jan. 1919, K. A. Lansdell, 11807; Feb. 1920, J. C. Howlett, 12789, det. Lloyd; April 1921, C. Punt, 14513; April 1921, A. M. Bottomley, 14515a; Silverton, Pretoria, March 1928, L. Reinecke, 23202; Johannesburg, E. Dyke, 26587; Xumeni Forest, Donnybrook, Natal, June-July 1935, E. M. Doidge, 28905; Jan. 1935, 28904; Stellenbosch, Oct. 1921, P. v. d. Byl 479; Bosfontein Kloof, Rustenburg Dist., May 1939, E. M. Doidge & A. M. Bottomley, 35120; Garstfontein, Pretoria, April 1911, E. M. Doidge, 1337, Kew as *G. tenuipes*; Meintjes Kop, Pretoria, March 1905, A. M. Bottomley, 20388; Kirstenbosch, M. Levyns (E.L.S. 87); nr. Stikland, C.P., J. P. H. Acocks, July 1932 (E.L.S. 141); nr. Rhodes Memorial, June 1934, J. P. H. Acocks (E.L.S. 346); Newlands, Woods (E.L.S. 425).

*Specimens not seen*: Tarkastad, C.P., N. J. G. Smith 33b; Stellenbosch, L. Verwoerd (v. d. Byl 2032); Queenstown, C.P., F. Pope (N. J. G. Sm. G. 97).

This species is recognised by its long, slender pedicel and usually long, beaked, sulcate mouth; the endoperidium is often covered with a whitish, floury substance and its base often shows striations or furrows with or without an apophysis.

I have followed Hollós in considering *G. plicatum*—the form with a plicate endoperidial base—a synonym of *G. pectinatum*, since all gradations of the distinguishing endoperidial basal characters are often found in plants of one collection, and it has been found impossible to refer such a collection as a whole to either species. Most of the South African plants have a striate or sulcate base, the smooth form occurring much less frequently.

2. **Geastrum Bryantii** Berkeley, . . . [Plate XLIX, fig. 5.]

Outlines of British fungi (1860) 300.

Sacc. Syll. Fung. 7 (1888) 75; Verwoerd, Ann. Univ. Stell. 3 (1925) 23; Lloyd, Geastreae in Myc. Writ. 1 (1902) 16; Rea, Basid. (1922) 40.

*Geaster orientalis* Haszl., Grev. 6 (1877) 108.

*G. Kunzei* Wint., in Rabenh. Krypt. Fl. 1 (1884) 911.

This species is very closely related to *G. pectinatum*, from which it differs only in the presence of a well-defined collar or ring around the base of the endoperidium just above the pedicel.

*Habitat* : as for *G. pectinatum*.

*Distribution* : South Africa; Australia; North America.

*Specimens examined* : Fountains, Pretoria, Feb. 1927, A. M. Bottomley, 21200; without locality (v. d. Byl 1422 ex herb. C. G. Lloyd).

*Specimens not seen* : Pretoria, A. Martin (N. J. G. Sm. G. 91 and Wit. Herb.).

The South African plants so far seen do not show as definite a collar as illustrated for plants of this species in other countries, in fact this character appears to be more in the nature of an exaggerated or sharp-rimmed apophysis. Plants with a normal apophysis occur in the above collection (21200) together with others showing the more typical *G. Bryantii* character.

3. **Geastrum nanum** Persoon, [Plate XLIX, fig. 6; L, fig. 2.]

Memoire, Journal de Botanique 2 (1809) 27.

Hollós, Gastero. Ungar. (1904) 55, 152.

*Geaster Schmideli* Vitt., Monogr. Lycop. (1842) 157; Coker & Couch, Gastero. (1928) 134.

*G. Rabenhorstii* Kunze in Rabenh. Fung. eur. (1875).

*G. striatus* Kalchbr., Adalok Szepesség virányához 2 (1862) 154.

*Exoperidium* 1.5–3 cm., split to about the middle into 5–9 unequal, acuminate rays, typically recurved, often expanded, with or without recurved tips; *fleshy layer* adnate, smooth or less often cracked, ochraceous-brown to umber-brown; *mycelial layer* persistent, covered with adhering soil and vegetable debris. *Endoperidium* 5–11 mm. across, shortly pedicellate, subglobose, oval or urn-shaped, usually with a slight to pronounced basal apophysis, pale to umber brown or leaden grey, due to a whitish farinose covering; pedicel typically short (1–1.5 mm.) cylindrical or elliptic. *Mouth* sulcate, elevated, shortly and acutely conical, concolorous with, or often darker than the remainder of the peridium, seated on a well-defined, depressed peristome. *Gleba* dark umber brown. *Columella* sometimes present, small, oval. *Capillitium* threads pale to dark, usually thinner, but sometimes thicker, up to 8  $\mu$ , than the spores. *Spores* brown with darker episporule, verrucose, 4–6.8  $\mu$  diam.

*Habitat* : in open or shaded places, on bare ground or in humus.

*Distribution* : South Africa; Australia; North America; England; Europe.

*Specimens examined* : Pretoria, Feb. 1923, C. Punt, 17004; Irene, nr. Pretoria, Nov. 1932, General J. C. Smuts, 26600; Kromrivier, Rustenburg Distr., Dec. 1938, E. M. Doidge & A. M. Bottomley, 35123; Grahamstown, Oct. 1933, N. J. G. Smith 55, 27513; Elim Hospital, Louis Trichardt, Tvl., Nov. 1932, P. Thomas, 26601; in *Eucalyptus*

plantation, Potchefstroom, July 1935, *J. Sellschop*, 28271; in red sand under *Acacia*, Mauritzenfontein, Kimberley, June 1936, *J. P. H. Acocks* 401, 35130; Mossel River nr. Hermanus, Dec. 1938, *Miss Esterhuysen* (*E. L. Stephens* 446) 35024; Fischhoek, July 1937, *D. Peers* (E.L.S. 445).

This species is distinguished from *G. pectinatum* by its small size, shorter and proportionately thicker pedicel, shorter, more conical mouth and more commonly expanded exoperidium. It is so different from *G. pectinatum* in all the South African collections so far seen, that I have followed Hollós (l.c.) in keeping the two species separate.

**4. *Geastrum campestre* Morgan,** [Plate L, fig. 3.]

*American Naturalist* 21 (1887) 1026.

*Sacc. Syll. Fung.* 7 (1888) 471; *N. J. G. Smith* in *Rec. Albany Museum, Grahams-town* 4 (1935) 275; *Cunningham Gastero.* (1944) 165.

*Geaster pseudomammosus* P. Henn., *Hedwigia* 39 (1900) 54.

*G. asper* (Mich.) Lloyd *Geastreæ in Myc. Writ.* 1 (1902) 18; *Hollós Gastero. Ung.* (1904) 57.

Unexpanded plant up to 1.7 cm. diam., depressed globose, dirty white with adhering vegetable debris, originally submerged. *Exoperidium* hygroscopic, up to 3.5 cm. diam., splitting two-thirds of the way into 7-10 subequal, lanceolate segments, involute when dry, folding under or on the side of the endoperidium, with one or several segments over or under, seldom completely over; expanded when moist, with tips slightly turned up. *Fleshy layer* umber, smooth or cracking off when wet, in the latter case exposing the whitish fibrillose layer; *mycelial layer* thin, with debris attached, finally often peeling off. *Base* strongly umbilicate. *Endoperidium* subglobose, up to 1.5 cm. diam., shortly pedicellate, dirty white, greyish, buff or pale brown, minutely but densely covered with whitish to pale brown granules. *Mouth* seated on a depressed area, sulcate, short or long to almost beaked, paler, concolorous or darker than remainder of endoperidium. *Gleba* usually very dark, blackish brown, sometimes pale brown. *Columella* present, small, white, spherical. *Capillitium* tinted to pale brown, typically less than spore diameter. *Spores* large, globose, dark brown, 4.5-6.8  $\mu$  diam., strongly verrucose.

*Habitat* : on ground and in humus.

*Distribution* : South Africa; North America; Australia; Europe.

*Specimens examined* : Mooibank, Potchefstroom Distr., Feb. 1924, *H. O. Lawrence*, 18123, 18124, det. Lloyd as *G. asper*; Irene-Delmas Road, Tvl., *I. B. Pole Evans*, 24921; St. Helena Bay, *R. Smathers*, April 1936 (E.L.S. 1423).

*Specimens not seen* : South-West Africa, *Dinter*; Carolina, Tvl., *E. Young* (N. J. G. Sm. G. 179 & Herb. Wit.); Queenstown, C.P., *F. Pope* (Albany Museum, N. J. G. Sm. G. 7 and Kew).

This species, more commonly known as *G. asper*, is characterized by its hygroscopic habit, sulcate mouth and asperate and shortly pedicellate endoperidium. The plants are typically involute when dry, but individual specimens may dry in a partly or wholly recurved position.

According to Cunningham, *G. campestre* has spores 6-8  $\mu$  diam. and *G. Clelandii* (Lloyd) Cunn. spores 4-5.5  $\mu$ . N. J. G. Smith (l.c.) however, found that in South African plants, spores to include both sizes were present in the same collection. The latter opinion is confirmed by an examination of Transvaal material. All South African plants have therefore been referred to *G. campestre*.

5. **Geastrum ambiguum** Montagne.

*Florula Boliviensis* (1839) 47.

Hollós Gastero. Ung. (1904) 19, 153, Tab. 9, f. 15-17; Sacc. Syll. Fung. 7 (1888) 78.

*Geaster Drummondii* Berk., London Journ. Bot. 4 (1845) 63; Verwoerd, Ann. Univ. Stell. 3 (1925) 21.

*Geaster striatulus* Kalchbr., in Grev. 9 (1880) 3.

*G. Schweinfurthii* P. Henn., in Engl. Bot. Jahrb. 14 (1891) 361.

*G. involutus* Mass., in Grev. 2 (1892) 3.

*Geastrum Drummondii* Berk., G. H. Cunn., Gastero. (1944) 167.

*Unexpanded plant* small, globose, submerged then superficial. *Exoperidium* hygroscopic, 1·2-3·5 cm. diam., split to about the middle, or two-thirds of the way into 5-11 lanceolate, acute, more or less equal rays, which are fully expanded when wet and strongly involute over or under the endoperidium when dry; *fleshy layer* adnate, umber, smooth or transversely rimose; *Mycelial layer* dirty white, at first covered with debris, becoming more or less smooth, slightly umbilicate. *Endoperidium* sessile or very shortly pedicellate, subglobose, 0·8-1·6 cm. diam., brownish grey, dirty white, smoke grey or drab, densely or obscurely granular to almost smooth. *Mouth* definite, sulcate, conical, concolorous or slightly darker than remainder of peridium. *Gleba* dark brown. *Capillitium* threads attenuated, usually thinner than spore diameter, almost hyaline to pale brown. *Spores* globose or less often subglobose, distinctly but rather sparsely verrucose, pale brown with dark episore, 4·5-6·8  $\mu$  diam.

*Habitat*: in sand or in open or shaded ground.

*Distribution*: South Africa; Australia; Tasmania.

*Specimens examined*: in open field, Dundee, Natal, Dec. 1909, E. M. Doidge, 956, det. Lloyd as *G. striatulus*; under *Acacia Karroo*, Bedford, C.P., Nov. 1915, J. Gane, 9199, det. Lloyd as *G. striatulus*; on termite mound, Butterworth, C.P., Nov. 1915, P. N. Doran (Pegler 2367) 9200, as *G. striatulus*; nr. Graafwater, C.P., I. B. Pole Evans, 33182; Garstfontein, Pretoria, April 1911, P. J. Piernaar, 1353; St. Helena Bay, April 1936, R. Smithers (E. L. Stephens 423) 35122; Sibangwana, N. Zululand, Nov. 1938, H. W. Martley, 35021; Stellenbosch, April, A. V. Duthie, 35032; ? bank of Anghrabies River, Barnard (S.A.M. 45945 as *G. saccatum*).

*Specimens not seen*: on sandy patches under trees, nr. Grahamstown, Queenstown, C.P., Tarkastad, and Alice, N. J. G. Smith G. 90, G. 171 (Albany Museum, Kew as *G. Drummondii*); Port Elizabeth, E. Archibald; Stellenbosch, G. Nel (Stell. 1105, 1139 as *G. Drummondii*); Brandfort, L. Verwoerd (Stell. 2083 as *G. Drummondii*); Olukonda in Amboland, S.W.A., Schinz; without locality, P. Hennings as *G. Drummondii*.

This species, better known as *G. Drummondii*, is recognised by its hygroscopic nature, its sessile endoperidium and sulcate mouth.

6. **Geastrum quadrifidum** Persoon, [Plate L, fig. 1.]

*Synopsis Methodica Fungorum* (1801) 133.

*Geaster coronatus* (Schaeff.) Schroet. Pilze in Krypt. Fl. Schlesiens 3 (1889) p.p., non *G. coronatus* Persoon (1801); Lloyd, Geastreae in Myc. Writ. 1 (1902) 31; Hollós, Gastero. Ung. (1904) 61.

*Exoperidium* typically fornicate, up to 3·5 cm. high (excluding cup) and 3 cm. wide, splitting about two-thirds of the way into 4-5, occasionally 6 segments, the margins of which curl under, giving the segments a long narrow appearance. On expansion, the

mycelial layer remains behind in the substratum as a hollow, membranous, cup-shaped structure, while the fleshy and fibrous layers separate from it, become strongly arched in the centre, finally standing erect with the tips of the rays still attached to the corresponding tips of the mycelial cup; *fleshy layer* brown, smooth, finally usually cracking and peeling off either in patches or altogether, exposing the tough, ochraceous, membranous fibrous layer. *Endoperidium* pedicellate, 0.7-1.9 cm. wide, depressed-globose or urceolate, usually with a circular, constricted apophysis at the base just above the pedicel; covered with minute white particles, finally usually smooth, pale grey to brownish grey, becoming bay-brown in weathered specimens. *Pedicel* up to 2.5 mm. long, broadly elliptic. *Mouth* fibrillose-fimbriate, very occasionally inclined sulcate, concolorous or paler or darker than remainder of endoperidium, usually conical, sometimes almost plane, seated on an often paler, well-defined area outlined by a definite, depressed margin. *Gleba* umber. *Capillitium* threads tinted to brown, up to 6.8  $\mu$  diam. *Spores* globose, almost hyaline, pale brown, minutely and sparsely verrucose, 2.5-3.4  $\mu$  diam.

*Habitat*: in humus under trees and bushes.

*Distribution*: South Africa; Australia; North and South America; Europe; India; New Zealand.

*Specimens examined*: Stella Bush, Durban, July 1914, *Indian Collector* (v. d. Byl 689) 31895; Umgeni, Natal, Sept. 1917, *G. Hobbs* (v. d. Byl 754) 31942; Durban, v. d. Byl 524, 35131 as *G. fornicatus*; Aug. 1917, *Leslie* (N.H. 744) 32486.

This species, probably better known as *G. coronatum*, is recognised by its fornicate habit and fibrillose-fimbriate mouth, which is outlined by a definite, depressed margin. Except for the mouth characters and smaller spores, this plant is very like the South African form of *G. fornicatum*. It is rather longer and narrower in proportion than the typical form and the rays look narrower on account of the margins being curled under. The spores are smaller than mentioned by Hollós and Cunningham, but agree with those seen by Verwoerd (l.c.).

According to Smith (l.c.) who submitted specimens to Cunningham, the latter considers this plant to be a form of *G. fornicatum* (*G. fenestratum*) but judging from various descriptions and illustrations, it appears more closely to resemble the plant called *G. coronatus* by Hollós, Lloyd, Coker and Cough and Verwoerd.

#### 7. *Geastrum dissimile* n. sp., [Plate LI, fig. 1-2.]

Peridio juvēne depresso-globoso, 2-5 cm. diam., mycelio albo intermixto quisquiliis humi tecto. *Exoperidio* typice fornicato, ad ultra medium in plerumque 4, rarius 5 segmenta partito; segmentis acuminatis cuneatisque, marginibus aliquando revolutis; interno griseo ('Light Drab'), castaneo, umbrino, persistente vel secedente; medio griseo vel pallido-fusco; externo rigidulo, crassiusculo, mycelio albo intermixto, quisquiliis humi tecto, calyciformi ad terram manente. *Endoperidio* depresso-globoso vel urceolato, stipitato, plerumque versus basim constricto, griseo, brunneo-griseo, umbrino-atro, tenuiter granulato; pedicello albo, elliptico, usque 3 mm. longo; peristomio determinato, saepe subtiliter elevato, concolori aut discolori, crasse fibrilloso, fere sulcato, non distincte depresso marginato cincto. *Gleba* umbrina. *Columella* parva, obtusa. *Hyphis* capillitii longis, brunneis levibus, ad 8.5  $\mu$  cr. *Sporis* globosis, brunneis, subtiliter et parce verrucosis, 3.4-4.1  $\mu$  diam.

*Geastrum quadrifidum* affinis sed differt praecique ostiolo qui fere sulcato et non depresso marginato cinctus est.

Hab. in humo, Fountains, Pretoria, leg. A. M. Bottomley, 14515 b.

Unexpanded plant depressed-globose, 2.5 cm. diam., covered with white mycelial threads mixed with humus debris. *Exoperidium* typically fornicate, splitting two-thirds of the way into 4, occasionally 5, acuminate or wedge-shaped segments, the margins of which often curl under; fleshy layer grey (Light Drab), chestnut brown (Verona Brown), umber, persistent or peeling off from the tips and margins upwards; fibrous layer grey or pale brown; mycelial layer thick, covered with debris, forming at the base of the plant a well-developed cup which may become completely detached in old specimens. *Endoperidium* pedicellate, depressed-globose or urceolate, usually with a well-defined, circular, basal apophysis just above the pedicel, dove grey, brownish grey, umber or brownish black, finely granular or rugulose; pedicel white, elliptical, up to 3 mm. long; mouth definite, often slightly raised, concolorous or lighter or darker than the remainder of the endoperidium, coarsely fibrillose to almost sulcate, not surrounded by a definite margin. *Gleba* umber. *Columella* small, obtuse. *Capillitium* threads long, brown, simple, smooth, up to 8.5  $\mu$  thick. Spores globose, brown, finely and sparsely verrucose, 3.4-5.1  $\mu$  diam.

*Habitat* : in humus under trees and shrubs.

*Distribution* : South Africa.

*Specimens examined* : Fountains, Pretoria, Feb. 1920, *J. C. Howlett*, 12790; March 1936, *K. Lansdell & A. M. Bottomley*, 28457; April 1921, *A. M. Bottomley*, 14515 b, type; Johannesburg, May 1945, *A. M. Bottomley*, 35132; Fairy Glen, Pretoria, Jan. 1928, *L. Reinecke*, 23165.

This species closely resembles *G. quadrifidum*, but differs in the coarse, fibrillose to sulcate mouth and in the absence of a depressed margin around the mouth area. In general structure and appearance it also resembles *G. fornicatum*, but the latter has an indefinite mouth. It was originally thought that this plant might be *G. MacOwani*, since the latter has the same type of mouth as depicted by Lloyd (Myc. Writ. 2, 1907: pl. 96) for Prof. Plötzner's South African specimens, but Mr. Talbot, South African mycologist working at Kew, kindly compared one of our specimens with that in Kew Herbarium named by Lloyd *G. fornicatus* Huds. form *MacOwani* Kalchbr. and informs me that our plant is smaller, lighter in colour and of a different texture.

#### 8. *Geastrum minimum* Schweinitz, [Plate LII.]

Schrift. der Naturforschenden Gesellschaft zu Leipzig 1 (1822) 32, non Chevallier Sacc. Syll. Fung. 7 (1888) 80; Hollós, Gastero. Ung. (1904) 159; Lloyd, Geastrae in Myc. Writ. 1 (1902) 27, 28; Verwoerd, Ann. Univ. Stell. 3 (1925) 22.

*Geaster marginatus* Vitt., Monogr. Lycoperd. (1842) 19.

*G. Cesatii* Rabenh., Bot. Zeit. 9 (1851) 628.

*G. granulosus* Fuck., Enumerat. 15 (1860) 41.

*G. calceus* Lloyd, Myc. Writ. 2, Myc. Notes 25 (1907) 311.

*Exoperidium* 0.9-3 cm. wide, splitting to about half way into 7-9 unequal acuminate rays, typically recurved, but often more or less expanded with slightly incurved tips, not fornicate; fleshy layer ochraceous, brownish-grey, umber, often paler round the edges, adnate, becoming cracked but not peeling off to any extent; mycelial layer covered with adhering debris, not separating from the fleshy and fibrous layers to form a basal cup. Base concave to vaulted. *Endoperidium* shortly pedicellate, 4-9 mm. diam., subglobose or more or less oval, grey or buff in colour, finely furfuraceous, with or without an apophysis, non-weathered plants covered with whitish granules. Mouth fimbriate, conical, seated on a relatively large, circular area surrounded by a well-defined groove. *Gleba* umber brown. *Capillitium* threads usually paler and thinner than the spores. Spores 3.4-5  $\mu$  globose, distinctly but rather sparsely verrucose, brown with darker episporae.

*Habitat* : Amongst vegetable debris under bushes and trees and in open ground.

*Distribution* : South Africa ; North and South America ; Australia ; Europe ; Japan ; India ; New Zealand.

*Specimens examined* : under pine trees, Grahamstown, March 1931, N. J. G. Smith, G. 34, 25899, Kew, Albany Museum ; Johannesburg, Jan. 1925, C. N. Knox Davies, 20394 ; Magaliesberg, Nov. 1917, V. A. Putterill, 11006, det. Lloyd ; under *Acacia caffra*, Fountains, Pretoria, Dec. 1914, I. B. Pole Evans, 8781 ; open ground amongst rocks, Premier Mine nr. Pretoria, Nov. 1913, I. B. Pole Evans, 7100 ; Boschberg Mt., Somerset East, 1875, MacOwan 1174 (S.A.M. 35068) 35304, as ' *G. granulatus*' ; Stellenbosch, A. V. Duthie (E.L.S. 53).

*Specimens not seen* : without locality, Prof. Plotter (Lloyd Myc. Coll. 57280 as *G. calceus*, Plate LXI, fig. 2). Lloyd describes this as " a large *G. minimus* with the endoperidium densely covered with coarse, white, granular particles " ; without locality, Herb. Berlin as *G. granulosus* ; Kentani, Oct. 1906, A. Pegler 1370, Kew ; Cape Province, 1891, P. MacOwan, Kew.

This species is recognised by its small size, recurved or expanded, but not fornicate exoperidium, short pedicel, well-defined peristome surrounded by a definite groove and the presence of whitish granules (described by Hollós as glistening crystals) on the peridium of young plants. It resembles *G. quadrifidum* in peristome characters and the surface of the endoperidium, but differs from it in its usually smaller size, absence of mycelial cup, larger and darker spores and usually thinner capillitium.

Coker and Cunningham consider that the fornicate character is only a stage of the *minimum* form and exclude the latter as a separate species ; but in no South African collection have the two forms so far been found together, nor do transitional forms occur in either species. The plants are so markedly different in habit and appearance that it is proposed to follow other mycologists in this country and retain *minimum* as a separate species.

#### 9. *Geastrum limbatum* Fries. [Plate LIII.]

*Systema mycologicum* 3 (1829) 15.

Hollós, Gastero. Ung. (1904) 75 ; N. J. G. Smith, Rec. Albany Mus. 4 (1935) 269 ; G. H. Cunningham, Gastero. (1944) 169 ; Lloyd, Geastreae in Myc. Writ. 1 (1902) 23.

*Geaster limbatum* var. *ellipsostoma* Smith l.c.

*Exoperidium* 3.5-8.5 cm. diam., split to the middle or beyond into 7-10 unequal, acute or long acuminate rays, which become typically recurved or may be expanded with incurved or revolute tips ; *fleshy layer* bay brown, umber brown, greyish brown or occasionally silver grey (Drab, Hair Brown, Warm Sepia) continuous or cracked in all directions, adnate or peeling off either partially or entirely in weathered specimens ; *fibrous layer* pale tan or dirty white ; *mycelial layer* at first with large amount of adhering debris, which may later disappear entirely or only from the basal portion, or it may persist, depending on whether the rays become involute or revolute. *Base* plane or concave, often vaulted. *Endoperidium* pedicellate, 1.2-3 cm. diam., sub-globose, depressed globose, urn-shaped or sub-pyriform, with or without a basal apophysis, grey, parchment coloured, ochraceous, pale greyish-brown, dark umber (Mouse Grey, Drab, Wood Brown) slightly to densely farinose, obscurely pitted, or almost smooth when old. *Pedicel* whitish, greyish, umber, often paler than the peridium, elliptical, 3-4 mm. thick, 2-4 mm. long, sometimes with a depressed ring around the base. *Mouth* fimbriate, often depressed, plane or short to long conical, surrounded by a paler, darker or concolorous, round to elliptical, fibrillose to almost

sulcate, silky zone. *Gleba* umber to blackish brown. *Columella* usually present, small to very large. *Capillitium* threads paler than spores, up to 7  $\mu$  diam. *Spores* brown with darker episporule, globose slightly to strongly verrucose, sometimes almost papillate, 3.7-6.8  $\mu$  including the warts.

*Habitat* : amongst leaves under trees, gregarious.

*Distribution* : East and South Africa ; North America ; Australia ; Britain ; Europe ; New Zealand.

*Specimens examined* : Meintjes Kop, Pretoria, March 1921, *A. M. Bottomley*, 14501, det. Lloyd ; April 1925, 20434 ; under Acacias, Fountains, Pretoria, March 1925, *A. M. Bottomley*, 20390 ; March 1936, *A. M. Bottomley*, 28652 ; Town Bush, Pietermaritzburg, Nov. 1934, *W. G. Rump* 313, 28675 ; Hopevale, Donnybrook, Natal, *K. E. Morgan*, 28623, Feb. 1935, 35023, Oct. 1934, 35026, *E. M. Doidge*, Jan. 1935, 28812, 28813 ; under *Podocarpus*, Hogsback, Alice, C.P., about 1932, *A. Lyle* (N. J. G. Sm. G. 351 as *G. limbatus* var. *ellipsostoma* N. J. G. Smith) 27809 ; Haenertsburg, N. Tvl., *E. M. Doidge*, July 1934, 27803 ; Garstfontein, Pretoria, March 1944, *A. M. Bottomley*, 35133, *E. M. Doidge*, 35018 ; Xumeni Forest, Donnybrook, Dec. 1943, *E. M. Doidge*, 35167 ; Brenton, Knysna, *G. R. Duthie*, 35028.

*Specimens not seen* : Somerset East, *MacOwan* 1236 ; Palm Kloof, Victoria Falls, S. Rhodesia, Cheesman.

This species is distinguished by its often dark colour, the definite, fimbriate mouth, the pedicellate endoperidium and the dark, verrucose spores. The exoperidium is typically reflexed, as in fornicate types, but the rays of old weathered specimens are often involute, in which case the mycelial layer breaks away from the arched base and peels off with the adherent debris up to the tips of the rays, where remains are often seen. Involute specimens sometimes resemble *G. triplex*.

Smith's variety *ellipsostoma* is considered to be only an extreme form of the species, since an examination of seventy-four plants, representing one collection from the same spot on the same day, showed a gradation of mouth shapes, on which the variety is founded, from spherical to broadly oval and narrowly elliptical. Further, the spores of Smith's specimen, N. J. G. Sm. G. 35, deposited in the National Herbarium, are no more verrucose, in fact are less so, than those of several other collections examined ; the spore size falls within the range of that of the normal type. Our specimen No. 27803 from Haenertsburg, shows the same elliptical mouth, but larger, more verrucose spores and the endoperidium more thickly farinose.

#### 10. *Geastrum triplex* Junghuhn, [Plate LIV ; LV.]

Tijdschrif voor Natuurlich Gesch. en physiologie 7 (1840) 285.

Hollós, Gastero. Ung. (1904) 73 ; N. J. G. Smith, Rec. Albany Mus. 4 (1935) 270 ; G. H. Cunn., Gastero. (1944) 172.

*Geaster lageniformis* Vitt., Monogr. Lycoperd. (1842) 16.

*G. Archeri* Berk., Fl. Tasm., 2 (1860) 264.

*G. Michelianus* W. G. Sm., Gard. Chron. (1873) 608.

*G. vittatus* Kalchbr. & Cooke, Grev. 9 (1880) 3.

*G. capensis* Thümen in Mycoth. univ. 815 ; Sacc. Syll. Fung. 7 (1888) 85 ; Verwoerd, S. Afric. Journ. Sci. 23 (1926) 292.

*G. Morgani* Lloyd in Myc. Writ. 1, Myc. Notes 8 (1901) 80.

*G. squamosus* Lloyd in Myc. Writ. 2, Myc. Notes 26 (1907) 339.

*Geastrum Archeri* (Berk.) Boedijn, Bull. Jard. Bot. Buitenzorg, 16 (1940) 412.

*Unexpanded plant* depressed globose with a prominent, straight or oblique point, dirty white to pale ochraceous, glabrous, sometimes shining, attached to a mass of copiously branched, white mycelial threads. *Exoperidium* up to 8 cm. wide when expanded, splitting to about half way or more into 5-8 rays, which in typical plants are long acuminate; *fleshy layer* ochraceous, cinnamon, reddish brown or umber, usually becoming cracked, and in wet weather often cracking and peeling off from the tip to the base of the rays, leaving the remainder behind as a cup-shaped structure around the base of the endoperidium; *mycelial layer* thin, glabrous, often shining, usually pale greyish-ochraceous and free from debris, often splitting longitudinally along the rays, or radially from the base, into striae. *Base* usually concave, umbilicate. *Endoperidium* up to 2.5 cm. diam., sessile, depressed or sub-globose, concolorous with, or lighter or darker than the inner surface of the exoperidium, membranous, glabrous. *Mouth* almost plane or typically short to long conical, fibrillose, usually but not always surrounded by a well-defined, broad peristome, which is sometimes limited by a raised margin, concolorous with, or paler or darker than the rest of the endoperidium. *Gleba* usually umber in mature specimens. *Capillitium* threads variable, usually paler than the spores and up to thicker than the spore diameter. *Columella* either large and clavate or indistinct. *Spores* 4-5.5  $\mu$  diam., average size about 4.5  $\mu$ , usually dark and strongly verrucose when mature.

*Habitat*: usually amongst vegetable debris under trees or shrubs.

*Distribution*: South Africa; North and South America; Australia; Britain, Europe; Tasmania; New Zealand.

*Specimens examined*: Pretoria, March, 1921, 14502; Feb. 1912, *J. C. Howlett & C. Coetze*, 2136; Fountains, Pretoria, April 1921, *A. M. Bottomley*, 14642; Jan. 1919, *K. Lansdell*, 11808; *J. C. Howlett*, Feb. 1920, 12791; *L. C. Turner*, Jan. 1915, 8811; March 1936, *A. M. Bottomley & B. Lonwres* 28458; Silverton, Pretoria, March 1928, *L. Reinecke*, 23196 a; Garstfontein, Pretoria, April 1911, *P. J. Pienaar*, 1352, 1353, 1354, 1356, Kew; Aapies River, Pretoria, March 1942, *E. J. Scott*, 33755; Meintjes Kop, Pretoria, April 1925, *A. M. Bottomley*, 20422; near Umtata Falls, C.P., Feb. 1929, *McLoughlin*, 30508; Brenton, Knysna, *Duthie* 322, 31486; Papegaaisberg, Stellenbosch, June 1921, *Duthie* 307, 31475; April 1929, 35031; Stellenbosch, *A. V. Duthie* (E.L.S. 52); Kirstenbosch, Newlands, C.P., *A. M. Bottomley*, 24840; Hopevale, Donnybrook, Natal, Dec. 1940, *E. M. Doidge*, 35119; Jan. 1935, 35118; March 1933, *K. E. Morgan*, 32200; Feb. 1935, 35017; Quden, Nkandla Distr., Zululand, March 1939, *J. Gerstner* 3255, 30758; Cape Peninsula, *E. L. Stephens* 140; Kirstenbosch, C.P., July 1934, *A. M. Acocks* (E. L. Stephens 371) 27676; Kentani, C.P., Feb. 1915, *A. Pegler* 1978, 9546; Haenertsburg, Tvl., March 1938, *S. Thompson* (T. R. L. 280) 29938; O.F.S., Jan. 1937, *Miss Olivier* (E. L. Stephens 444) 35020; locality unknown, Feb. 1916, *J. M. Sim*, 9440; Potchefstroom, Tvl., March 1939, *M. Gunn*, 30512; locality unknown, *R. Marloth*, 26610; Boschberg Mts., Somerset East, *MacOwan* 1236, Type of *G. capensis* (S.A.M. 35057) 35303, Kew; ? Boschberg Mts., *Tuck* (MacOwan 1124 as *G. fimbriatus* (S.A.M. 35059) 21941; Inanda, Natal, *J. Medley Wood* 489 as *G. fimbriatus*, 11154, 10414.

*Specimen not seen*: Woodbush (Wit. Herb. 232).

Typical plants of this species are distinguished by the following characters—large size, long acuminate rays, broad conical mouth, usually glabrous, longitudinally striate underside of the exoperidium and large, dark, strongly verrucose spores. Variations of these characters are, however, frequent and specimens are often very difficult to distinguish from *G. saccatum*. *G. lageniformis* is *G. triplex* with unusually narrow acuminate rays and a fimbriate mouth clearly defined by a broad, silky surrounding zone.

*G. capensis* Thüm. is indistinguishable from *G. triplex*. MacOwan's type specimen, *MacOwan 1236*, is 9 cm. diam. and is split two-thirds of the way into six broad, tapering segments, from which the fleshy layer splits in a characteristic manner. The inner peridium is globose, with a definite, fimbriate mouth surrounded by a paler zone.

South African specimens of *G. fimbriatum* appear to be a mixture of *G. triplex* and *G. saccatum*; J. Medley Wood's specimens, *Medley Wood 489*, have the typical spores of *G. triplex* but the felted mycelial layer of *G. saccatum* as interpreted by Hollós; MacOwan's No. 1124 have the spores of *G. saccatum* but the glabrous mycelial layer of *G. triplex*. In no case is the mycelial layer coated with debris. In all these specimens the mouth is fimbriate and seated on a definite but not limited peristome. European specimens distributed by Rathay, Hollós and Rabenhorst have an indefinite mouth without a peristome. Of two specimens distributed by Sydow, however, in his *Mycotheca Germanica*, one has an indefinite non-peristomatic mouth and a glabrous mycelial layer, while the second has a finely fimbriated peristomatic mouth and a felted mycelial layer. Both specimens are free from debris, which Cunningham considers *G. fimbriatum* should have. There would therefore still appear to be considerable difference of opinion with regard to this species, but since the general opinion seems to be that *G. fimbriatum* should at any rate, have an indefinite mouth, the South African specimens have been referred to *G. triplex*, which they most nearly resemble.

A specimen (in Roy. Bot. Mus. Berlin) collected by Dr. H. Schinz in South-West Africa (*Hedwigia* 28, 1889 : 7) and identified by Dr. Ed. Fischer as "near *G. fimbriatus*" except for the larger size of the spores, may possibly likewise be *G. triplex*, since he describes the mouth as fimbriate and separated from the rest of the endoperidium by a circular groove; the size of the spores is given as 4-5  $\mu$  diam.

### 11. *Geastrum saccatum* Fries, [Plate LVI.]

*Systema Mycologicum* 3 (1829) 16.

Ed. Fischer, *Nat. Pflanzenfam.* 7a (1933) 73; G. H. Cunningham *Gastero* (1944) 172; Lloyd, *Geastreæ in Myc. Writ.* 1 (1902) 37; Hollós, *Gastero. Ung.* (1904) 71, 157; Verwoerd, *Ann. Univ. Stell.* 3 (1925) 21.

*Geaster Lloydii* Bres. et Pat., in Lloyd *Myc. Writ.* 1, *Notes No.* 6 (1901) 50.

*G. velutinus* Morgan, *Journ. Cincinnati Soc. Nat. Hist.* 18 (1895) 38.

*G. velutinus* var. *caespitosus* Lloyd, *Geastreæ in Myc. Writ.* 1 (1902) 36.

*Unexpanded plant* up to 2 cm. diam., globose or subglobose without the point, mucronate or abruptly fairly long pointed, buff to reddish brown, typically tomentose- to strigose-felted, sometimes smooth, epigaeal, attached to a mass of white mycelial threads. *Exoperidium* 0.7-6 cm. wide, but usually small to medium, saccate, occasionally drying recurved, splitting to about half way into 5-10 acute segments, the tips of which are usually recurved, but may remain upright or expanded; *fleshy layer* thick and fleshy at first, finally thin, smooth or cracking and peeling off irregularly, cream to delicate liliaceous pink, drying to a light brown, greyish brown, bay brown or umber; *mycelial layer* ochraceous, pale brown or reddish brown, usually more or less felted, tomentose-felted or sometimes strigose-felted adnate or peeling off in patches, sometimes with debris adhering. *Base* concave, flat or convex, usually with an umbilical scar. *Endoperidium* up to 1.5 cm. diam., subglobose, sessile, finely tomentose at first, finally more or less glabrous, concolorous with, or paler or darker than, the exoperidium, usually partly enclosed by the saccate base of the latter. *Mouth* fibrillose, plane, shortly and broadly conical or occasionally long conical. *Gleba* umber. *Capillitium* threads tinted to pale brown, sometimes rough, average width equalling the spore diameter, sometimes larger. *Columella* indistinct. *Spores* globose, moderately to fairly strongly verrucose, brown with darker epispor, 3.5-4.5  $\mu$ , usual size about 4  $\mu$  diam.

*Habitat* : solitary or gregarious, sometimes in hard exposed ground, usually in humus in shaded positions.

*Distribution* : Africa ; North and South America ; Australia ; Britain ; Europe ; West Indies ; Tasmania.

*Specimens examined* : Pretoria, May 1925, *A. M. Bottomley & C. Punt*, 20584 ; March 1925, *A. M. Bottomley*, 20393 ; March 1924, 18182 ; March 1921, *E. M. Doidge*, 14482 ; Feb. 1923, *C. Punt*, 17003 ; April 1913, *I. B. Pole Evans*, 6684 ; July 1913, *I. B. Pole Evans*, 7099 ; Feb. 1915, 8810 ; Fountains, Pretoria, Dec. 1914, *I. B. Pole Evans*, 8765 ; Jan. 1928, *L. Reinecke*, 23146 ; April 1921, *A. M. Bottomley*, 14642 ; March 1924, 18139 ; April 1921, 14495 ; Feb. 1921, 14480 ; *L. C. Turner*, Nov. 1915, 8811 ; Fairy Glen, Pretoria, Jan. 1928, *L. Reinecke*, 23166 ; March 1939, *E. M. Doidge*, 32201 ; Garstfontein, Pretoria, March 1944, *E. M. Doidge*, 35019 ; *E. M. Doidge*, 35033 ; Silverton, Pretoria, March 1928, *L. Reinecke*, 23196b ; Barberton, Tvl., March 1924, *G. Thorncroft*, 18125 ; Sibasa, Zoutpansberg, Feb. 1920, *H. A. Junod*, 12825 ; Van Reenen, Dec. 1912, *M. Franks*, 5665 ; Sweetwaters, Natal, Dec. 1934, *A. Spencer*, 30831 ; Brenton, Knysna, *A. V. Duthie* 174, 31382 ; Kirstenbosch, Newlands, July 1934, *J. Acocks*, (E. L. Stephens 370) 27672 ; Umtali, S. Rhodesia, *F. Eyles* 4227 (v. d. Byl 2416) ; Salisbury, S. Rhodesia, April 1926, *F. Eyles* 4086 (v. d. Byl 2350) ; Durban, *van der Byl* 618 ; Schroeders, Natal, *van der Byl* 898 ; Kentani, C.P., 1906, *A. Pegler* 1425 a, as *G. Minimum*, 34449 ; Oct. 1908, *Pegler* 1370, 8418, 34450 and Kew ; Garstfontein, Feb. 1942, *A. M. Bottomley*, 35134 ; May 1944, *A. M. Bottomley*, 35135 ; Hermanus, C.P., May 1934, *Dr. MacPherson*, 31492 ; Bulwer, Natal, Feb. 1937, *W. G. Rump* 464, 35302 ; Montagu, C.P., April 1929, *D. v. H.*, 35025 ; July 1929, 35027.

*Specimens not seen* : Brenton, Knysna, *Duthie* 95, 235, 289 ; Sterkstroom, *du Plessis* (Duthie 214) ; Somerset Strand, C.P., *L. Verwoerd* (Stell. 124) ; South-West Africa, *Dinter*.

South African plants of this species appear to be distinguished from *Geaster triplex* to which it is closely allied, mainly by the nature of the underside of the exoperidium, which is usually tomentose—felted in *G. saccatum* and usually glabrous in *G. triplex*. The decision to use this character as a separating factor was based on an examination of numerous collections, comprising several hundred plants, many of the individual specimens of which could have been referred some to one species and some to the other if separated on other points. The exoperidial character was found to be the only well-defined, fairly constant point of difference between the two types occurring in this country. Both Hollós and Coker describe *G. saccatum* as having a felted mycelial layer, but Cunningham describes it as glabrous like *G. triplex*, referring plants with a felted layer to *G. velutinum*. Cunningham separated the Australian plants of the two species under discussion on characters such as spore size, shape of rays, nature of peristome, striate nature of the mycelial layer, but in South African plants these characters show so many gradations in one and the same collection that it is impossible to use them alone as a basis of distinction. N. J. G. Smith found the same difficulty, and following Lloyd, used size as the separating factor, referring expanded plants of more than 5 cm. diam. to *G. triplex* and smaller plants to *G. saccatum*. As pointed out by Cunningham, however, this character is very variable and therefore unsuitable. The South African plants can really only be separated on a combination of characters. Generally speaking large plants with acuminate rays, glabrous, longitudinally striate mycelial layer and large, dark, strongly verrucose spores are *G. triplex* and small to medium sized plants with wedge-shaped rays, felted mycelial layer and smaller, paler, less verrucose spores are *G. saccatum*. Intermediate forms, however, with characters of both species are not infrequent.

## 12. *Geastrum mirabile* Montagne, [Plate LVII, fig. 1.]

*Annales des sciences naturelles*, 3 Sér., 4 (1855) No. 595.

*Sacc. Syll. Fung.* 7 (1888) 79 ; Lloyd, *Myc. Writ.* 2, *Myc. Notes* 25 (1907) 313 ; Cunningham, *Gastero.* (1944) 171 ; Coker & Couch, *Gastero.* (1928) 116.

*Geaster papyraceus* Berk. et Curt., Proc. Am. Acad. Arts & Sci. 4 (1858) 124.

*G. lignicola* Berk., Journ. Linn. Soc. 18 (1881) 386.

*G. caespitosus* Lloyd, Myc. Writ. 2, Myc. Notes 25 (1907) 315.

*Unexpanded* plants superficial, small, often caespitose, obovate, with a slight umbo when dry, 4-5 mm. across, cream coloured, finely felted, attached to a whitish mycelial membranaceous subiculum. *Exoperidium* saccate, up to 9 mm. across, split to about one third into 5-6 bluntly pointed, suberect rays; *fleshy layer* pale brown, smooth, adnate, sometimes peeling off from the tips of the rays; *mycelial layer* cream coloured, finely felted to strigose, free from debris. *Endoperidium* sessile, 4-5 mm. across, brown, lower third enclosed by the saccate base of the exoperidium. *Mouth* broadly conical, fibrillose, concolorous or darker. *Gleba* umber. *Spores* globose, brown, 3.5-4  $\mu$  diam., finely verrucose.

*Habitat*: often caespitose on a subiculum growing over decayed vegetable debris.

*Distribution*: West and South Africa; North and South America; Australia; Ceylon; West Indies; Japan.

*Specimens examined*: Rooikoppies, nr. Duivelskloof, Tvl., July 1939, Mr. Read (T.R.L. 199) 35022, det. Wakefield.

This species is distinguished from *G. saccatum*, to which it is nearly related, by its caespitose habit, cream colour, attachment to a membranaceous subiculum, generally smaller size, less sharply pointed button and slightly larger spores.

13. ***Geastrum velutinum* Morgan**, [Plate LVII, fig. 2.]

Journal Cincinnati Society of Natural History 18 (1895) 38.

Lloyd, Geastreae in Myc. Writ. 1 (1902) 33; Coker & Couch, Gastero. (1928) 113; G. H. Cunningham, Gastero. (1944) 170; N. J. G. Smith, Rec. Albany Mus. 4 (1935) 2.

? *Cycloderma ohiensis* Cooke et Morgan ex Cooke, Grevillea 2 (1883) 95.

*Geaster Lloydii* Bres. ex Lloyd, Myc. Writ. 1, Myc. Notes 6 (1901) 50.

*Unexpanded* plant subglobose or ovate and slightly pointed, superficial, attached to substratum by a well-developed mass of closely interwoven, white mycelial threads. *Exoperidium* 0.7-2.5 cm. across, splitting to about half way into 5-6 wedge-shaped, suberect or more or less expanded segments; *fleshy layer* cinnamon brown, usually smooth and adnate, sometimes cracking across the base of the rays; *mycelial layer* same colour as fleshy layer, finely felted to strigose. *Endoperidium* sessile, 7-12 mm. across, globose, greyish-brown, finely tomentose to glabrous. *Mouth* broadly conical, minutely fibrillose, seated on a slightly raised, almost concolorous, definite, circular area. *Capillitium* pale and thin, similar to spores in colour and diameter. *Spores* globose, dark brown, finely verrucose, 4-6  $\mu$  diam.

*Habitat*: on the surface of decayed vegetable debris.

*Distribution*: South and East Africa; North and South America; Australia; New Zealand.

*Specimens examined*: without locality, 35292.

*Specimens not seen*: Eastern Cape Colony, figured by Marloth in Flora of South Africa, Pl. 3; Grahamstown, N. J. G. Smith G. 162 (Albany Mus.).

It seems unlikely that Smith's plant, called *G. velutinum* (l.c.) is the same as that described in the present work. It is more likely to be *G. saccatum* as here interpreted. Our *G. velutinum* plants are characteristic cinnamon brown and are not as expanded as most *G. saccatum*.

This species, like *G. mirabile*, is known from one collection only. Its distinguishing features are its mycelial attachment, its felted to strigose mycelial layer, the sub-erect habit and the colour. It is separated from *G. mirabile* by its larger size, distinctive brown colour (Snuff Brown to Cinnamon Brown) and usually large spores. It is distinguished from *G. saccatum* mainly by the colour of the mycelial layer which is quite free from debris, its usually more conical mouth, its sub-erect habit and its generally larger spores.

The only specimens available for comparison were two unexpanded plants distributed by Dümmer from Uganda.

14. **Geastrum arenarium** Lloyd, [Plate LVII, fig. 3.]

Geastreeae in Myc. Writ. 1 (1902) 28.

N. J. G. Smith in Rec. Albany Mus., Grahamstown, 4 (1935) 273; G. H. Cunningham, Gastero. (1944) 174.

*Unexpanded plant* globose, small, originally submerged. *Exoperidium* hygroscopic, up to 3.5 cm. diam., splitting to the middle or beyond into 8-12 unequal, pointed segments, which are expanded when wet and incurved either above or, more often, below the endoperidium when dry; sometimes drying partly expanded; *fleshy layer* adnate, pale brown, sometimes peeling off and exposing the whitish fibrillose layer; *mycelial layer* covered with sand. *Base* strongly umbilicate. *Exoperidium* up to 1.6 cm. diam., subglobose, long or depressed globose, whitish or dove grey (Pallid Mouse Grey to between Tilleul Buff and Avellaneous) more or less mealy when young, becoming almost glabrous; shortly pedicellate. *Pedicel* elliptical, sometimes with a slight apical apophysis. *Mouth* typically fimbriate, conical, acute, definite or sometimes indefinite, darker than rest of endoperidium or concolorous. *Gleba* ferruginous. *Columella* indistinct, if present. *Capillitium* threads varying in thickness to size of largest spores, pale brown. *Spores* globose, 3.5-5.1  $\mu$  diam., brown, finely verrucose.

*Habitat* : in sandy places.

*Distribution* : South Africa; North America; Australia.

*Specimens examined* : on sandy river bank, Tarkastad, C.P., O. West (N. J. G. Sm., G. 37) 27512; under *Acacia* trees, Mauritzfontein, Kimberley area, June 1936, J. P. H. Acocks 402, 28637; under *Eucalyptus*, Grahamstown, Nov. 1915, 9198; Fort Hare, Alice, Aug. 1934, Giffen, 27503.

*Specimens not seen* : Queenstown, R. Hall; Grahamstown, N. J. G. Smith, G. 173; Boellacarpu nr. Kuruman, J. V. L. Rennie.

This species is recognised by its hygroscopic habit, its shortly pedicellate endoperidium and fibrillose peristome.

15. **Geastrum mammosum** Chevallier.

Flora Paris (1836) 359.

Sacc. Syll. Fung. 7 (1888) 85; Lloyd, Geastreeae in Myc. Writ. 1 (1902) 13; N. J. G. Smith, Rec. Albany Mus. 4 (1935) 274.

*Exoperidium* hygroscopic, thin, rigid, smooth, splitting almost to the base into 8-10 subequal, slender rays; *fleshy layer* chestnut brown, smooth; *mycelial layer* free of debris.

*Endoperidium* sessile, depressed globose, about 9 mm. diam., smooth, pale straw coloured, with a conical, even, protruding mouth seated on a large, silky, clearly defined zone. *Columella* short, globose, evident or not. *Capillitium* threads simple, tapering, hyaline, slightly thinner than spores. *Spores* globose, verrucose, 3-7  $\mu$  diam. (Description after Smith l.c. and Lloyd l.c.)

*Habitat* : on ground in open or wooded places.

*Distribution* : South Africa ; North America ; Britain ; Europe.

*South African record* : near Swakop River, between Omaruru and Okahandja, South-West Africa, N. J. G. Smith, G. 98 ; this collection (Smith l.c.) consists of a single detached specimen.

This species is characterised by its hygroscopic habit, sessile endoperidium and even conical mouth.

16. **Geastrum fornicatum** (Hudson) Fries (pro parte typica), [Plate LVIII.]

*Systema Mycologicum* 3 (1821) 12 pp.

Hollós, Gastero. Ung. (1904) 62 ; Lloyd, Geastreæ in Myc. Writ. 1 (1902) 29 ; N. J. G. Smith, Rec. Albany Mus. 4 (1935) 278 ; G. H. Cunningham, Gastero. (1944) 175.

*Lycoperdon fornicatum* Huds., Flor. Angl. ed. 1 (1762) 502, (pp.).

*Geastrum quadrididum* v *fenestriatum* (Batsch) Pers. Syn. (1801) 133.

*Geastrum fenestriatum* (Pers.) Fischer, Natur. Pflanzenfam. 7a. (1933) 73.

*Unexpanded plant* subglobose, ochraceous. *Exoperidium* typically fornicate, up to 4 cm. high (excluding cup), 5.5 cm. wide, splitting about two-thirds or more of the way into 4, occasionally 5, acuminate or long wedge-shaped segments, the tips of which remain attached to the corresponding tips of the mycelial layer, which, on expansion, remains behind in the substratum as a membranous, hollow, cup-shaped structure ; the fleshy and fibrous layers, carrying the endoperidium become strongly arched over it ; *fleshy layer* greyish brown to umber (Mars Brown, Vandyke Brown) at first smooth and adnate, later sometimes cracking and peeling off, either altogether or in patches, exposing the usually hard, greyish brown fibrous layer. *Endoperidium* pedicellate, up to 1.7 cm. across and 1.4 cm. high, depressed globose or urceolate, often with a circular basal apophysis just above the pedicel, greyish brown to purplish black (Mouse Gray, Light Drab, Drab, Vandyke Brown), velvety, smooth or obscurely granular. *Mouth* indefinite, conical or mammose, with fibrillose or lacerate apex. *Pedicel* whitish, elliptic, up to 2 mm. long and 5 mm. wide. *Gleba* umber with purplish tinge. *Columella* small, hemispherical. *Capillitium* threads brown, up to 7  $\mu$  diam. *Spores* globose, finely but sparsely verrucose, brown, 4-5.1  $\mu$  diam.

*Habitat* : in humus under bushes and trees.

*Distribution* : South Africa ; Australia ; North America ; Britain ; Europe ; West Indies.

*Specimens examined* : Platrvier, Pretoria Distr., Nov. 1911, P. J. Piernaar, 1966, det. Lloyd ; Saltpan, west of Waterpoort, N. Tvl., Dec. 1932, H. Schweickerdt, 26623 ; Belvidere, Knysna, A. V. Duthie 95, 31349 ; Kimberley, Oct. 1918, M. Wilman, 12317 ; under *Acacia*, Mauritzfontein, Kimberley Distr., June 1936, J. P. Acocks 401, 28636 ; Trappe's Valley, Bathurst Distr., C.P., Aug. 1919, H. Cromwright (N. J. G. Smith G. 9) 12466 ; Kentani, Jan. 1916, A. Pegler 2386, 9419 ; Knysna, A. V. Duthie (v. d. Byl 1092) ; June 1921, Eyles 6658 (S. Rh. 3861) ; Durban, April 1917, Leslie (N.H. 744) 32486.

*Specimens not seen* : Tarkastad, O. West [N. J. G. Smith, G. 33 as *G. fenestriatus* (Pers.) G. H. Cunn.]; Commadagga, Somerset East Distr. (Alb. Mus. G. 96 as *G. fenestriatus*); Kimberley (Herb. Wit. 234); Cape of Good Hope, MacOwan as *G. MacOwani* Kalchbr. ; without locality, Prof. Plöttner.

Typical plants are distinguished by the strongly fornicate habit and the indefinite, apically fimbriate mouth. The South African plant appears to differ from the typical European plant mainly in smaller size and larger spores. It more nearly resembles the Australian and the North American form.

This species is distinguished from the plant here described as *G. coronatum* by the indefinite, non-margined mouth, larger and darker spores and thicker capillitium.

17. **Geastrum Hieronymi** P. Hennings, [Plate LXIX, lower row.]

Beiträge zur Pilzflora Sudamerikas II, in Hedwigia 36 (1897) 211.

Lloyd, Myc. Writ. 2, Myc. Notes (1907) 311, Pl. 97; Myc. Writ. 7 (1923) 1176; Verwoerd, Ann. Univ. Stell. 3 (1925) 22; N. J. G. Smith, Rec. Albany Mus. 4 (1935) 279.

*Exoperidium* expanded or with rays revolute, splitting to about the middle or more into 8-10 subequal, acuminate rays 1-2 cm. long; *fleshy layer* umber, sometimes with paler margin around rays, 4-6 cm. diam., almost smooth at first, becoming rimosely or longitudinally cracked; *mycelial layer* adnate, covered with debris, ochraceous or greyish brown, sometimes breaking away. *Base* deeply concave or vaulted. *Endoperidium* pedicellate, ovoid, subglobose or depressed globose, 1.5-2.5 cm. diam., with or without a basal apophysis, shortly stipitate, umber or blackish umber, minutely but densely and harshly asperate; spicules black, erect, sharp pointed. *Mouth* indefinite, fimbriate, concolorous with, or a shade darker than the rest of peridium. *Pedicel* broad elliptic, 1-2 mm. long, with scattered spines. *Gleba* blackish umber. *Capillitium* varying in thickness and colour from tinted to almost as dark as spores, and from thin to slightly thicker than spore diameter. *Spores* globose, dark brown, sparsely verrucose, average size 4  $\mu$ .

*Habitat* : on ground amongst vegetable debris.

*Distribution* : North and South America; South Africa.

*Specimens examined* : Knysna, A. V. Duthie 290 (v. d. Byl 1091; Stell. 125) 31460; Platrivier, Pretoria Distr., Nov. 1911, P. J. Pienaar, 1967; Kromrivier nr. Marikana, Transvaal, Dec. 1938, E. M. Doidge and A. M. Bottomley, 35121; Stellenbosch, C.P., April 1923, F. Eyles, 6756.

*Specimens not seen* : under plants, Grahamstown, N. J. G. Smith.

This is a very dark species, distinguished by its minutely, but densely and harshly asperate endoperidium. Hennings describes the spicules as resembling those of *Lycoperdon perlatum*. It is very near *G. fimbriatum* except that the endoperidium of the latter is sessile and smooth.

18. **Geastrum floriforme** Vittadini, [Plate LXIX, upper row.]

Monographia Lycoperdineorum (1842) 23.

Sacc. Syll. Fung. 7 (1888) 87; Verwoerd, Ann. Univ. Stell. 3 (1925) 21; N. J. G. Smith in Rec. Albany Mus. 4 (1935) 277; G. H. Cunningham, Gastero. (1944) 177.

*Geaster delicatus* Morg., American Nat. 21 (1887) 1028.

*G. hungaricus* Hollós, Gastero. Ung. (1904) 64.

*G. Pazschkeanus* P. Henn., Hedwigia 39 (1900) 55; Sacc. Syll. Fung. 16 (1902) 239.

*Unexpanded plant* subglobose, depressed globose, sometimes pointed at the apex, dirty white, at first submerged, then entirely superficial. *Exoperidium* 2.5-3.5 cm. diam. when expanded, splitting from a half to two-thirds of the way into 5-11 subequal, acuminate segments, strongly hygroscopic, folded over the peridium when dry, saccate with tips expanded or revolute when moist; *fleshy layer* smooth or transversely cracked, bay to umber brown; *mycelial layer* thin, whitish, at first with adherent sand, more or less disappearing, exposing the smooth, brown, fibrous layer. *Base* slightly umbilicate or rounded with point of attachment present. *Endoperidium* sessile, 9 mm. to 1.5 cm. diam., subglobose, parchment coloured to light brown, almost smooth. *Mouth* a torn aperture, indefinite, naked, slightly conical or plane, becoming fibrillose. *Gleba* nigger brown. *Columella* minute, white, rounded. *Capillitium* threads varying in thickness up to diameter of largest spore, almost hyaline to light brown. Spores usually globose, sometimes subglobose, strongly verrucose, 3.6-7  $\mu$  diam.

*Habitat*: singly or gregarious on ground.

*Distribution*: South Africa; North America; Australia; Europe; New Zealand.

*Specimens examined*: Pretoria, Nov. 1909, *Doidge*, 957; *P. J. Pienaar*, Nov. 1911, 1968, det. *Lloyd*; Krugersdorp, Tvl., Oct. 1928, *A. J. Pretorius*, 23625; Matatiele, E. Griqualand, Oct. 1932, *Gideon Joubert*, 26577; Raapenberg Golf Course, Cape Peninsula, Aug. 1938, *M. A. Pocock* (E. L. Stephens 218) 27272; Stikland, Bellville, C.P., July 1932, *J. Acocks*, 27274; Stellenbosch, v. d. *Byl*, 1107; May, 1923, v. d. *Byl*, 1105 as *G. striatulus*, *G. C. Nel* (v. d. *Byl* 1139) as *G. striatulus*; Stellenbosch, April 1921, *Eyles* 6756; Brandfort, O.F.S., Feb. 1925, *L. Verwoerd* (v. d. *Byl* 2083) as *G. striatulus*; Elsenburg, C.P., Oct. 1926, 35029.

*Specimens not seen*: Eastern Cape, *N. J. G. Smith* *G. 19*, *G. 28*; Grahamstown, *G. 90*; Devil's Peak, Cape Town, amongst leaves at foot of Leucadendron tree 1894, *MacOwan*, Kew; Cape Province, *Pazschke* as *G. Pazschkeanus*.

#### 19. *Geastrum hygrometricum* Persoon, [Plate LX.]

*Synopsis Methodica Fungorum* (1801) 135.

*Sacc. Syll. Fung.* 7 (1888) 90; *Verwoerd*, *S. Afric. Journ. Sci.* 23 (1926) 291; *G. H. Cunningham*, *Gastero.* (1944) 178.

*Geastrum fibrillosum* Schw., *Nat. Gesell.* (1822) 113.

*Geaster vulgaris* Corda, *Icon. Fung.* 5 (1842) 64.

*Astraeus hygrometricus* (Pers.) Morgan, *Journ. Cincinnati Soc. Nat. Hist.*, 12 (1889) 20.

*Geaster lilacinus* Mass., *Kew Bull.* (1899) 166.

*Astraeus stellatus* (Scop.) Fischer, *Nat. Pflanzenfam.* 1 (1900) 341.

*Unexpanded plant* 4-7 cm. diam., globose or depressed globose, bay-brown, rooting by a few fine threads, submerged at first, finally completely superficial. *Exoperidium* very hygroscopic, 5-10 cm. diam. when expanded, splitting to two-thirds to three-quarters of the way into 5-20 thick, woody, subequal, acute segments, which are strongly incurved over the endoperidium when dry, but in wet weather expand and turn back, until the plant is lifted off the ground and rests on the tips of the segments; *fleshy layer* light brown or greyish (between Deep and Dark Olive Buff) in fresh specimens, finally yellowish, greyish, dark brown to almost black in weathered specimens; thin, often cracking rimose or into sections, giving the segments a mottled or shagreen appearance; *mycelial layer* thin, tearing away as the plant expands, exposing the smooth, polished, brown fibrillose layer. *Endoperidium* 2-3.3 cm. diam., globose or depressed globose, sessile, thin, membranaceous, at first covered with an olive green, woolly covering, leaving the peridium smooth and buffy

Brown flecked with Citrine Drab in colour. *Mouth* indefinite, a torn aperture without a peristome. *Gleba* umber. *Capillitium* threads long, attenuated, branched, pale brown, 3.5-7  $\mu$  diam. Spores globose, verrucose, 5-10  $\mu$  diam.

*Habitat* : solitary or gregarious, occurring sporadically in rainy seasons, in manured or other ground.

*Distribution* : South Africa ; North and South America ; Australia ; Europe ; India.

*Specimens examined* : in manured ground, Somerset East, 1874, *MacOwan 1060* (S.A. Museum 35065), 35305 ; on hard ground under pine trees, Pretoria, April 1925, *A. M. Bottomley*, 20421 ; March 1929, 23724 ; April 1930, *P. Watson*, 25435 ; Feb. 1946, *B. Louwrens*, 35524.

*Other South African Records* : Marloth (Flora S. Afric. 1, 1913 : 21) says of this plant : "The common *G. hygrometricus* is of universal occurrence".

This species is recognised by its large size, very woody exoperidial segments, rigidly incurved habit when dry, and picturesque habit of standing on the tips of its segments when wet. In the latter condition it reminds one of some sea animal.

Cunningham is followed in retaining this species in *Geastrum* rather than Morgan and Fischer who referred it to a separate genus—*Astraeus*. According to the first-named, it differs from other *Geastrums* only in having a somewhat primitive hymenium, which is, however, not evident at maturity.

#### Doubtful Species.

**Geaster MacOwani** Kalchbr. [Plate LXI, fig. 1.]

*Grevillea* 10 (1882) 108.

"Habitu *G. fornicati* Fr. sed. triplo major. Peridium extereus quadrifidum, laciinis ovato-lanceolatis, peridium interius breviter stipitatum, glabriuscum, sporae fusco-purpureae.

C.B. Sp., leg. MacOwan.

Orificio—proh dolor—totam destructum sed numerus loborum et color sporarum characteres bonos praebet".

No specimen of this species appears to have been deposited in any South African Herbarium. Mr. Talbot, to whom a specimen of *G. dissimile* n. sp. was referred for comparison with the Kew material of *G. MacOwani*, has supplied the following note :—"There is only one specimen in Kew called *G. MacOwani*. It was collected by MacOwan in the Cape, identified originally as *G. limbatus* from which it was transferred by Lloyd, who has labelled it *G. fornicatus* Huds. form *MacOwani* Kalchbr. This specimen corresponds very well with Lloyd's illustrations (Myc. Writ. 2, 1907 : Plate 96) of Prof. Plöttner's material, but it is not the same as your specimen (*G. dissimile*). Furthermore it seems doubtful whether Lloyd's conception of *G. MacOwani* is the same plant as Kalchbrenner described (l.c.). *G. MacOwani* is stated to be three times as large as *G. fornicatus* (European form) which in turn is much larger and coarser than 14515 (*G. dissimile*) and also larger than the specimen called forma *MacOwani* by Lloyd. *G. MacOwani* is further confused by having been described from material in which the mouth was totally destroyed."

#### Excluded Species.

Verwoerd (Ann. Univ. Stell. 3, 1925 : 41) lists *Geaster affinis* Colenso and *G. coriaceus* Colenso as South African species, but he has obviously mistaken the name of the author for

a South African town of the same name. These are both New Zealand or Australian species. According to Cunningham (Gastero., 1944 : 173) *G. coriaceus* is a synonym of *G. triplex* and *G. affinis* (l.c., p. 211) is probably a synonym of the same species.

### 9. MYRIOSTOMA Desvaux.

*Journal de Botanique* 2 (1809) 103.

Lloyd, Geastreae in Myc. Writ. 1 (1902) 6 ; Verwoerd in Ann. Univ. Stell. 3 (1925) 24.

*Lycoperdon* Dickson, Plant. Crypt. Brit. I (1785) 24.

*Geastrum* Persoon, Syn. (1801) 131.

*Geaster* Auct. var.

This genus resembles *Geastrum* in all respects, except that the endoperidium dehisces by several mouths, and has several pedicels and columellas instead of one. It is represented by the single species *Myriostoma coliforme*.

**Myriostoma coliforme** (Dickson ex Persoon) Corda., [Plate LXI, fig. 3-4.]

Hazslinsky, Magyarhon Lasgombái (1875) 11 ; Corda, Anleitung zum Studium der Mycologie (1842) Tab. D.

Hollós, Gastero. Ung. (1904) 46 ; Verwoerd, Ann. Univ. Stell. 3 (1925) 241  
Coker & Couch, Gastero. (1928) 138.

*Lycoperdon coliforme* Dickson, Plant., Crypt. Brit. 1 (1785) 24.

*Geastrum coliforme* Dickson ex Persoon, Synops. Fung. (1801) 131.

*Myriostoma anglicum* Desv., Obs. in Journ. Bot. 2 (1809) 104.

*Geaster coliformis* Dickson ex Persoon, Kalchbrenner, Grev. 10 (1882) 108 ; P. Hennings, Engl. Bot. Jahrb. 14 (1892) 361.

*Geaster columnatus* Lév., Champignons de Mus. de Paris, p. 161.

*Bovistoides simplex* Lloyd, Myc. Writ. 6, Myc. Notes 61 (1919) 883.

*Exoperidium* 5-9 cm. diam., greyish brown or dull cinnamon, membranaceous, splitting to about half-way into 6-10 pointed, usually smooth segments ; *fleshy layer* adnate, firm and rigid at first, later peeling off, leaving the segments thin, membranaceous and a dirty white colour ; *mycelial layer* brown, smooth, with adhering debris, partly disappearing. *Endoperidium* 2-4.5 cm. diam., subglobose or depressed-globose, scabrous, brownish with shiny leaden grey effect, pedicellate, supported on several, more or less confluent, columnar structures, dehiscing by 7-15 indefinite mouths, which resemble torn apertures and are round or elliptic, plane or slightly elevated and scattered over the upper part of the endoperidium. *Gleba* umber brown. *Capillitium* threads pale brown, unbranched, tapering, 3.5-4  $\mu$  diam. *Columella* present, filiform, number probably corresponding with number of pedicels supporting endoperidium. *Spores* globose, strongly verrucose to almost papillate, pale brown, 3-7  $\mu$  diam.

*Habitat* : in open ground or leaf mould under trees, solitary.

*Distribution* : South Africa ; North and South America ; England ; Europe.

*Specimens examined* : Pretoria, April 1914, H. A. Wager, 7726 ; Wonderboom, Pretoria, June 1916, L. Kresfelder, 9793 ; March 1917, 10048 ; Pelindaba, Pretoria Distr., Feb. 1930, P. Watson, 24952 ; nr. Grahamstown, Sept. 1941, L. Britten, 33382 ; Aicedale,

*F. Cruden*, 12958; *Knysna, Duthie* 112 (v. d. *Byl* 1090) 31355; *Garstfontein Rd.*, *Pretoria*, May 1944, *A. M. Bottomley*, 35166; *Ubombo, Zululand, Bell Marley* (v. d. *Byl* 870); *Stikland, C.P.*, July 1932, *J. P. H. Acocks* (E. L. Stephens 135); *Brackenfel, C.P.*, Feb. 1933, *J. P. H. Acocks* (E.L.S. 171); May 1932, *E. L. Stephens* 116; *Heathfield*, Aug. 1937, *D. Cousins* (E.L.S. 443); *Blikfontein, Kimberley area*, Dec. 1937, *J. P. H. Acocks* 2585, 35301; *Boschberg, MacOwan* 1234 (S.A.M. 35056) 21940; *Huisrivierbergen, v. d. Byl* 1071.

*Specimens not seen* : *Belvidere, Knysna, Duthie* 59, 95; without locality, *Transvaal*, *v. d. Byl*; *Grahamstown, N. J. G. Smith*; *Cradock, M. Gush*; *Somerset East, MacOwan*.

#### 10. GEASTEROPSIS Hollós.

*Növénytani Közlemények* 2 (1903) 72.

*Geasteroides* W. H. Long, *Mycologia* 9 (1917) 24.

Peridium double. Exoperidium thick, rigid, splitting, as in *Gastrum*, from the apex downwards to about the middle, into irregular reflexed segments; closely investing the endoperidium. Endoperidium thin, membranaceous, more or less deciduous, enclosing a central structure, which arises from the base of the exoperidium and consists of a persistent, stipitate columella, which bears the capillitium and spores.

Long (l.c.) states that his genus *Geasteroides* differs from *Geasteropsis* in having a sterile persistent base to which the lower part of the endoperidium is firmly attached, whereas, according to the description and figures given by Hollós, the dehiscent endoperidium of *Geasteropsis* encloses the subligneous stipe and columella, making quite a different plant from *Geasteroides*.

In the specimens described later, believed to be *Geasteropsis*, the endoperidium appears to be originally attached to the exoperidium around the base of the stipe, thus enclosing the stipe with columella and gleba. One specimen in a South African collection indicates that the endoperidium may originally have been attached to the stipe slightly above its base, but even so it virtually encloses the stipe, columella and gleba. In any case the endoperidium is not firmly attached to the stipe as described by Long for *Geasteroides*. No specimen of the latter genus has been seen so no comparison is possible. Fischer is followed in including *Geasteroides* in *Geasteropsis*.

This genus differs from *Gastrum* and *Myriostoma*, to which South African genera it is most nearly related, by the manner of dehiscence, which, in *Geasteropsis*, is effected by the rupturing of the endoperidium, instead of by one or more apertures in the persistent endoperidium.

Three species have been described for this genus, *G. texensis* (Long) Ed. Fisch., from *Texas*, *G. Stahelii* Ed. Fisch. from *Surinam* and *G. Conrathii* Hollós.

**Geasteropsis Conrathi** Hollós, [Plate LXII; LXIII.]

*Növénytani Közlemények* 2 (1903) 72.

Peridium double, subglobose or obovate, dirty white, smooth, dull or shiny; originally attached by a smooth, thick, solid, whitish root-like structure; expanded plant varying from 7–16 cm. tall and 8–20 cm. broad. Exoperidium splitting from the apex downwards, to about the middle, into 8–10 pointed, reflexed or incurved segments, which are finally woody, hard and brittle, up to 6 cm. thick when soaked and consisting of three layers—an inner thin, dirty white, finally brownish grey layer, a thick, punky, brown middle layer and an outer white, compact, fibrous layer. With expansion, the inner and middle layers

become fissured and cracked, exposing the dirty white or brownish fibrous layer. *Endoperidium* thin, soft, membranaceous, pale brownish grey or dove grey, enclosing a central structure consisting of the gleba-bearing stipitate columella, originally attached at the top to the apex of the unexpanded exoperidium and at the bottom to its base, around the foot of the stipe of the columella. When the exoperidium splits at the apex, and the segments separate, the endoperidium breaks away at the top and partly or entirely at the bottom, remaining behind either as a torn, loose, collar-like structure around the base of the gleba or as torn fragments partly attached to the exoperidium thus partially or completely exposing the gleba. *Gleba* up to 2 cm. diameter exclusive of columella stipe, dark chocolate brown or blackish, consisting of closely packed, pale yellowish brown, irregular, fibrillose tramal strands, attached to and radiating from the massive columella, intermixed with capillitium and spores. *Columella* whitish, tough, subwoody, subglobose or elliptic, stipitate, broader than tall, 2-5 cm. tall and 1.4-6 cm. broad. *Stipe* cylindric or elliptic, in former case 2 mm. diam. by 0.5-1.3 cm. long, in the latter 3 cm. broad by 8 mm. thick and 2-7 mm. tall, arising from the outer, fibrous layer of the exoperidium. The enlarged apex of the stipe forms the columella. *Capillitium* threads sparse, hyaline to light brown, smooth, unbranched and only occasionally septate, diameter less than that of the spores. At maturity the gleba disintegrates and falls away from the columella, leaving the latter almost bare. *Spores* globose, olivaceous brown or dark brown, strongly verrucose, 5-8.5  $\mu$  diam., commonly 6.8  $\mu$ .

*Habitat* : on termite heaps and on ground, occurring singly.

*Distribution* : South Africa.

*Specimens examined* : on ground, Garstfontein, Pretoria Distr., April 1912, *P. J. Pienaar*, 2278; on termite heaps, Rietvlei Pasture Research Station, Pretoria Distr., May 1940, *J. P. H. Acocks* 12346, 34141; on termite heap, Clarens, O.F.S., July 1946, *J. E. v.d. Plank*, 35574; Danielskuil, Clanwilliam Distr., C.P., April 1940, *E. Esterhuijsen* (E.L.S. 510).

*Specimen not seen* : on granite soil, Modderfontein Dynamite Factory, Johannesburg, 1902, *P. Conrath*, Hollós, *Type* of genus and species.

The characteristics of this plant are the woody exoperidium, the fugacious endoperidium and the large, woody, stipitate columella, to which radiating, fibrillose strands intermingled with the capillitium threads are attached.

I am indebted to Miss Wakefield for the identification of specimens No. 34141, and for a copy of Hollós description of the species.

## TULOSTOMATACEAE.

The Tulostomataceae is the second family of the Order Lycoperdales and differs from Lycoperdaceae, the first family, mainly in the stem character, which is well developed in the Tulostomataceae but absent, or only very poorly developed, in Lycoperdaceae.

The Tulostomataceae is a comparatively small family, containing, according to Cunningham, only seven genera:—*Tulostoma*, *Batarrea*, *Phellorina*, *Chlamydopus*, *Podaxis*, *Schizostoma* and *Dictycephalos*, and these, with the exception of *Tulostoma*, contain only one to four species. Of the above seven genera only the first five are represented in South Africa.

Cunningham rather than Fischer is followed in the arrangement of this family, the argument of the former in favour of his arrangement being that although the genera in question show considerable diversity of form and development, they are grouped together because they have the ordinal characters in common, with, in addition, a well developed true stem.

The general characters of the family are as follows:—

Plants consisting of a peridium attached to a well developed stalk. Peridium sub-globose, depressed globose or long oval. Exoperidium 2-layered, scaly or continuous, persistent or fugacious. Endoperidium tough, membranous and persistent, except for *Batarrea* in which it falls away in one piece. Dehiscence by means of a stoma, by irregular rupture, by circumscissile splitting or by basal separation from the stem followed by longitudinal splitting. Stem woody and well developed, carrying the peridium upon its modified apex, except in the case of *Podaxis*, where it is prolonged to the apex of the peridium; provided with a volva-like structure at the base. Gleba pulverulent, consisting of copious spores and capillitium threads. *Capillitium* threads simple, sparingly branched, sparsely septate, hyaline or coloured. In *Batarrea* elaters are present mixed with the threads. Basidia fasciculate or in normal palisade arrangement on trama plates. Spores globose or oval, hyaline to coloured, usually rough.

#### Key to the Genera.

Sub-family Tulostomoideae. Basidia not in fascicles, disappearing at maturity.

- A. *Tulostomeae*. Elaters not present in the gleba.
  - Peridium dehiscing by a definite stoma; capillitium septate..... 1. **Tulostoma**.  
(*Schizostoma*).
  - Peridium dehiscing by irregular rupture of the apex; capillitium not septate..... 2. **Batarrea**.
- B. *Batarreae*. Elaters present in the gleba.
  - Peridium dehiscing by circumscissile cleavage of the apical portion... 2. **Batarrea**.
- Sub-family Podaxonoideae. Basidia in fascicles which persist at maturity.
- C. *Phellorineae*. Peridium seated on the expanded apex of the stem.
  - Peridial wall continuous with the stem forming a cupulate extension of the stem apex..... 3. **Phellorina**.
  - Peridial wall not continuous with the stem.
    - Peridium dehiscing by a definite stoma; gleba pulverulent..... 4. **Chlamydopus**.
    - Peridium dehiscing by irregular rupture of the apical portion; gleba coarsely chambered..... 5. **Dictycephalos**.
- D. *Podaxineae*. Peridium borne at the apex of a stem which traverses the gleba as an axile columella; dehiscing by longitudinal splitting.
  - Characters as above..... 6. **Podaxis**.

#### 1. TULOSTOMA Persoon.

*Synopsis Methodica Fungorum* (1801) 139.

*Tylostoma* Spreng., *Syst. Veg.* 4 (1829) 378.

*Tulasnodea* Fr., *Summa Veg. Scand.*, Pt. 2 (1849) 440.

Type species: *Tulostoma brumale* Pers.

Plants consisting of a stalked peridium in which the stalk is inserted in a depression at the base of the peridium. Peridium depressed globose, sometimes with a collar-like structure at the base. Exoperidium usually fugacious in the upper part of the peridium, but persistent at the base as an irregular, shallow disc. Endoperidium thin, tough, membranaceous, smooth or rough with fragments of the exoperidium, dehiscing by an apical

round, oval or elliptic mouth, which may be fibrillose, tubular, elevated or plane. Stalk inserted in a depression at the base of the peridium, woody, fistulose, often brittle, smooth or scaly, often striate or sulcate-striate, stuffed, usually with a small mycelial bulb at the base. *Gleba* pulverulent, consisting of capillitium threads and spores. Capillitium composed of long, usually branched, septate threads attached to the endoperidium. Spores globose, subglobose or occasionally angled, usually rough, occasionally smooth. " *Basidia* clavate, bearing laterally 2-4 spores on short sterigmata."

*Tulostoma* is the largest genus of the family Tulostomataceae, comprising some 85 described species, of which however, according to Cunningham, only about 30 are good. Probably about a dozen species are represented in South Africa. The genus is of world-wide distribution, occurring most commonly in dry, sandy regions. With the exception of two or three species which grow on wood, the species all occur on the ground. The chief characteristic of the genus is the stem, which is inserted into a depression at the base of the peridium. Only one other genus, namely *Schizostoma* has a stem of this nature. From *Schizostoma* however, *Tulostoma* differs in having a well-developed mouth and septate capillitium threads.

The genus is very imperfectly known in South Africa, the National Herbarium being sadly lacking in specimens of authentically named species. In the absence of named specimens for comparison and of facilities for studying overseas plants, great difficulty has been experienced in placing South African forms. However, rather than omit mention of many of the collections, it has been considered advisable, for the sake of future workers, to refer them tentatively to described species with which by comparison with descriptions and illustrations they seem most nearly to agree. Hollós, Lloyd, Coker and Couch and Cunningham have been the main sources of information.

The classification of the genus has been based, as is the usual custom, on the mouth characters. These are of three types: (1) definite, tubular and entire, (2) definite and fibrillose-fimbriate and (3) indefinite and plane, often resembling a torn aperture. Apart from the mouth, the spores appear to be the only other distinctive and variable character.

#### Key to the Species.

Mouth short, tubular, lantire

Spores typically small, 3.4-4.2 $\mu$ , obscurely verrucose.....	1. <i>T. Lesliei</i> .
Spores typically large, up to 10 $\mu$ .....	2. <i>T. album</i> .
Spores obscurely to finely verrucose, 5-10 $\mu$ .....	3. <i>T. Purpusii</i> .
Spores finely to distinctly verrucose, 4-6.8 $\mu$ .....	4. <i>T. albicans</i> .
Peridium large, up to 3 cm. diam.....	5. <i>T. bonianum</i> .
Peridium small, up to 1.5 cm. diam.....	6. <i>T. brumale</i> .
Spores typically medium sized, up to 6.8 $\mu$ .....	7. <i>T. squamosum</i> .
Spores finely echinulate. Mouth pale.....	8. <i>T. lacticeps</i> .
Spores strongly but sparsely echinulate. Mouth dark.....	
Spores verrucose, peridium reddish brown or pale tan.....	
Spores verrucose or shortly aculeate, peridium white.....	

Mouth fimbriate-fibrillose

Spores small, 3.4-5 $\mu$ , finely verrucose.....	9. <i>T. cyclophorum</i> .
Spores large, 6-7 $\mu$ , strongly aculeate.....	10. <i>T. Transvaalii</i> .
Spores large, 5.5-7 $\mu$ , minutely and sparsely verrucose.....	11. <i>T. Macowanii</i> .
Spores medium, 4-6 $\mu$ , more or less smooth.....	12. <i>T. obesum</i> .

Mouth indefinite, a torn aperture

Spores relatively smooth, 4-6 $\mu$ .....	13. <i>T. australianum</i> .
Spores finely and sparsely echinulate, 4-6.8 $\mu$ .....	14. <i>T. adherens</i> .

1. *Tulostoma Lesliei* van der Byl.

Transactions Royal Society of South Africa 9 (1921) 185.

Verwoerd, Ann. Univ. Stell. 3 (1925) 12.

*Peridium* subglobose or depressed globose, 7-9 mm. diam. *Exoperidium* disappearing from upper part of peridium but persistent at base. *Endoperidium* whitish to pinkish buff, smooth, membranous. *Mouth* round, tubular, elevated, sometimes surrounded by a slightly darker zone. *Stalk* 1.5-2 cm. long, 1-1.5 mm. thick, irregularly and distinctly striate, fistulose, equal, straight or twisted, with a few pointed, membranous scales at the apex. *Gleba* rusty brown. *Capillitium* hyaline to tinted, sparingly branched, fairly frequently septate, swollen and darker at the septa. *Spores* globose or subglobose, pale yellowish brown, obscurely verrucose,  $3\cdot4-4\cdot2 \mu$  diam.

*Habitat* : sandy soil.

*Distribution* : Natal; South Africa.

*Specimens examined* : Durban, *P. van der Byl* 57, *Type* and *P. v. d. Byl* 690, 31896.

This species differs from *Tulostoma albicans* in the shorter, thinner stalk and smaller spores. It is recognised by its light coloured endoperidium, elevated, tubular mouth and small, obscurely verrucose spores.

2. *Tulostoma album* Massee.

Grevillea 19 (1891) 95.

G. H. Cunningham, Gastero. (1944) 183.

*Tylostoma mcalpinianum* Lloyd, Myc. Writ. 2, Tylostomeae (1906) 15.

*Peridium* subglobose, 7-8 mm. diam. *Exoperidium* chestnut brown, disappearing from the upper part but persisting at the base, mixed with sand and leaf debris, to form a closely adhering disc. *Endoperidium* dirty white or parchment coloured, smooth except for scattered grains of sand, tough, membranous. *Mouth* circular, shortly tubular, entire, becoming somewhat lacerated. *Stem* 2-2.5 cm. long, 2-3 mm. thick, dark brown, fistulose, coarsely striate, somewhat lacerated when the pale brown or yellowish, shining under surface is exposed, expanded at base. *Capillitium* threads hyaline and tinted, rather sparingly branched, sparsely septate, slightly swollen at the septa, varying in thickness up to  $10\cdot2 \mu$ . *Spores* globose or subglobose, pale brown, thick-walled, varying considerably in size,  $5-10 \mu$ , average size about  $6 \mu$  diam., obscurely and finely verrucose (almost smooth in lacto-phenol).

*Habitat* : on ground.

*Distribution* : South Africa; Australia.

*Specimens examined* : in sheep kraal, Allandale Farm, Bathurst, C.P., Sept. 1935, *K. M. Putterill*, 28528.

The plants of the above collection are tentatively placed in *T. album* until further specimens are available for examination and an opportunity is afforded to compare them with authentically named specimens. The description given differs from that of Cunningham (l.c.) in the rather larger and smoother spores.

According to Cunningham (l.c.) *T. mcalpinianum* is the same as *T. album*. Lloyd (l.c.) described the spores of the latter as almost smooth while Cunningham found them to be coarsely verrucose. This divergence of opinion may be due to a difference in the mountant used for examination.

This species is recognised by its short tubular mouth, light coloured endoperidium and usually large spores which are relatively smooth.

**3. Tulostoma purpusii** P. Hennings, [Plate LXVI, fig. 3.]

*Hedwigia* 37 (1898) 274.

Lloyd, *Myc. Writ.* 2, *Tylostomeae* (1906) 18, Pl. 79; Verwoerd, *Ann. Univ. Stell.* 3 (1925) 12; G. H. Cunningham, *Gastero.* (1944) 185.

*Peridium* globose or depressed globose, 1.5-3 cm. diam. *Exoperidium* dark brown, mixed with sand, peeling off in irregular patches from the upper part but persistent at the base. *Endoperidium* thin, firm, smooth, dirty white, pale ochraceous, greyish brown, ferruginous or sometimes pale with ochraceous brown patches. *Mouth* 2-4 mm., round or oval, entire, slightly protruding, usually single but occasionally several. *Stalk* 2-4 cm., sometimes up to 8 cm. long and 2-6 mm. thick, single, or occasionally several anastomosed together, pale ochraceous, fistulose, striate, often scaly, with small mycelial bulb at base. *Gleba* rusty brown. *Capillitium* threads hyaline to tinted, varying in thickness up to 6.8  $\mu$  diam., sparingly branched, sparsely septate, slightly swollen at septa. *Spores* ochraceous brown, globose, subglobose or rather irregular, finely but distinctly verrucose, typically large, 4-6.8  $\mu$ .

*Habitat* : in sandy soil, single, gregarious, sometimes ceaspitose.

*Distribution* : South Africa.

*Specimens examined* : Stellenbosch, May 1923, *F. Eyles* (v. d. Byl 1132, 1134); June 1928, *A. V. Duthie* (E.L.S. 66); in wattle plantation, Donnybrook, Natal, 1936, *K. E. Morgan and E. M. Dodge*, 30272; Jan. 1935, *E. M. Dodge*, 27717; Feb. 1935, *K. E. Morgan*, 28910; Bloemfontein, *G. Potts*, 11690; Xumeni Forest, Donnybrook, Natal, Dec. 1940, *E. M. Dodge*, 35336.

The distinguishing features of this species are its unusually large size, and finely but distinctly verrucose spores. It differs from the next species in the typically larger size.

**4. Tulostoma albicans** White, [Plate LXVI; LXVIII.]

*Bulletin Torrey Botanical Club* 28 (1901) 428.

G. H. Cunningham, *Gastero.* (1944) 182; Lloyd, *Myc. Writ.* 2, *Tylostomeae* (1906) 15; W. H. Long, *Gastero.* XIII in *Mycologia* 38 (1906) 172.

*Tylostoma pallidum* Lloyd, *Myc. Writ.* 2, *Tylostomeae* (1906) 15.

*T. Mohavei* Lloyd, *Myc. Writ.* 6 (1920) 992.

*Peridium* depressed globose, 0.6-9 mm. high, 0.7-15 mm. wide, often with a crown of pointed scales at the base. *Exoperidium* disappearing entirely or in patches from the upper part, but persisting at the base as a shallow disc. *Endoperidium* dingy white or pale ochraceous, smooth or flecked with particles of exoperidium, tough, membranaceous. *Mouth* usually one, occasionally two, apical, usually round, sometimes elliptical, shortly tubular, margin even at first but may become dentate. *Stem* 1-4 cm. long, 1-3 mm. wide, ochraceous to reddish brown, striate to coarsely sulcate, more or less equal, bulbous at base. *Gleba* rusty brown. *Capillitium* threads hyaline to tinted, branched, sparsely septate, often somewhat swollen at septa, rounded at ends, up to 6.8  $\mu$  diam., equal or irregularly thickened. *Spores* globose, subglobose or sub-angled, sparsely but finely to coarsely verrucose, golden brown with darker episporae, 4-6.8  $\mu$  diam.

*Habitat* : in sandy or heavy ground.

*Distribution* : South Africa; North America; Australia; India; Tasmania.

*Specimens examined:* on anheap tennis court, Ladybrand, Feb. 1926, *P. L. Lefebre*, 20672; Fountains, Pretoria, Dec. 1914, *I. B. Pole Evans*, 8764; Bloemfontein, 11690; Garstfontein, Pretoria, Dec. 1911, *P. J. Pienaar*, 1969; Pretoria, March 1921, *E. M. Doidge*, 14481; in red sand under *Acacia* trees, Mauritzfontein, Kimberley, *J. P. H. Acocks* 403, 28638.

The distinguishing features of this species are the tubular mouth, light coloured endoperidium and verrucose spores.

It is uncertain whether collection No. 28638 (Plate LXVIII) is *Tulostoma olbicans* or not. It agrees in essentials with the description of this species as given by White (l.c.) and Cunningham (l.c.) but differs from illustrations in various respects. In size it varies from 0.7 to 3 cm. wide and 0.6 to 1.7 cm. high; the exoperidium is brittle, comparatively thick, shell-like and quite distinct from the endoperidium, thickly encrusted with closely adhering sand and breaks up into sections which fall away from the upper part of the endoperidium, leaving a thick, sand-encrusted cup-like structure at the base. The endoperidium is very white and finely furfuraceous at first, becoming pale greyish to pale ochraceous and quite smooth. The mouth is tubular, slightly elevated, round to oval, with a slightly irregular margin. The stalk is 2.7 mm. thick, 4-6 cm. long, dirty white to pale ochraceous, sulcate-striate, somewhat scaly and has a well-developed mycelial bulb at the base. Its characteristic features are the nearly white, pubescent endoperidium, which becomes pale grey or pale ochraceous and very smooth, and the shell-like, sand encrusted exoperidium.

**5. *Tulostoma bonianum* Patouillard,** [Plate LXVII, fig. 3.]

Bulletin Société Mycologique de France 8 (1892) 49.

Sacc. Syll. Fung. 11 (1895) 159; Lloyd, Myc. Writ. 2, Tylostomeae (1906) 14, Pl. 76.

Peridium 7-12 mm. wide, 5-8 mm. high, depressed globose or pulvinate, sometimes with an irregular crown of membranaceous scales at the base. Exoperidium dark reddish or umber brown, usually consisting of minute, brown, granular warts, which are persistent for some time, then fall away entirely or in irregular patches from the upper part, but persist at the base as an irregular cup-shaped disc. Endoperidium pale reddish or greyish brown or pinkish buff, usually finely areolate or reticulated where the exoperidial granules have fallen off. Mouths round, tubular, elevated, often surrounded by a pale zone, originally covered by the granular exoperidium. Stalk 1-6.5 cm. long, 1-3 mm. thick, slightly thinner at the apex and with a well developed mycelial pad at the base, medium to dark reddish brown, fistulose, striate, smooth or somewhat scaly. Capillitium threads hyaline or tinted, sometimes brown, branched, sparsely septate, somewhat swollen at septa, varying in thickness up to usually not more than diameter of spores. Spores globose or subglobose to angular, finely echinulate, 4.5-6  $\mu$  diam.

*Habitat:* often in large clusters in ground under bushes.

*Distribution:* South Africa; China; Cuba; India.

*Specimens examined:* Garstfontein road, Pretoria, Dec. 1911, *P. J. Pienaar*, 1969; April 1911, *E. M. Doidge*, 1344; Feb. 1939, *E. M. Doidge & A. M. Bottomley*, 30617; Fountains, Pretoria, April 1921, *A. M. Bottomley*, 14499; March 1935, 20378; Stellenbosch, *A. V. Duthie* (E.L.S. 67).

According to Patouillard (l.c.) this species is near to *Tulostoma mammosum* and *T. exasperatum*, differing from the former in the exoperidium and from the latter in the mouth and spore characters. In the specimens listed above, the mouth differs from that of *T. mammosum* in being paler instead of darker than the surrounding endoperidium. The species is characterised by the granular exoperidium, the protruding, pale, round, tubular mouth and the finely echinulate spores.

6. **Tulostoma brumale** Persoon.

*Synopsis Methodica Fungorum* (1801) 139.

G. H. Cunningham, *Gastero.* (1944) 184.

*Tulostoma mammosum* Fr., *Syst. Myc.* 3 (1829) 42; Lloyd, *Myc. Writ.* 2, *Tylostomeae* (1906) 16; Verwoerd, *Ann. Univ. Stell.* 3 (1925) 12.

*Tulasnodea leprosa* Kalchbr. ex Thuem. *Grev.* 4 (1875) 74.

*Tylostoma leprosum* Kalchbr. ex Cooke, *Grev.* 11 (1882) 59.

*T. pedunculatum* (L.) Schroet. in Cohn's *Beitr. Biol. Pflanz.* 3 (1887) 65.

*T. pygmaeum* Lloyd, *Myc. Writ.* 2, *Tylostomeae* (1906) 16.

*T. rufum* Lloyd, l.c., p. 18.

*T. floridanum* Lloyd, l.c.

*T. simulans* Lloyd, l.c.

*Peridium* globose to depressed globose, 6–12 mm. diam. *Exoperidium* dark brown, usually disappearing from most of the upper part, irregularly persistent at the base. *Endoperidium* pale tan or bay brown, smooth, membranaceous. *Mouth* 1–1.5 mm., shortly tubular, round, margin more or less entire, typically darker than the rest of the peridium, but sometimes concolorous. *Stem* 2–4 cm. long, 2–4 mm. thick, chestnut brown or umber, more or less equal except for small, basal, mycelial bulb, fistulose, coarsely striate, somewhat lacerate. *Gleba* rusty brown. *Capillitium* threads hyaline to tinted, branched, septate, septa usually moderately swollen and slightly darkened. *Spores* globose or subglobose, ochraceous brown, 4–6  $\mu$  diam., strongly but usually sparsely echinulate.

*Habitat* : on sandy ground.

*Distribution* : South Africa; North America; Australia; Britain; Europe.

*Specimens examined* : Boschberg Mts., Somerset East, 1876, *MacOwan* 1205 as *T. squamosum*, 20928, as *T. mammosum*, 20946; in old flower tins, Knysna, *A. V. Duthie* 147. 31371.

*Specimens not seen* : nr. Koega Rivier, *Zeyher* 123; Stellenbosch, *Verwoerd* (Stell. 43 v. d. Byl 2033); Kentani, *Pegler* 753.

This species is characterised by the smooth, pale tan endoperidium, the raised, shortly tubular and usually darker mouth and the echinulate spores. MacOwan's specimen has the typical dark mouth, septate capillitium and small size of *T. brumale*.

Verwoerd, l.c., describes the spores as relatively smooth, but in specimens examined by me they appear to be sparsely but strongly echinulate.

7. **Tulostoma squamosum** (Gmelin) Persoon.

*Synopsis Fungorum* (1801) 139.

Hollós, *Gastero.* *Ung.* (1904) 42, 148; Lloyd, *Myc. Writ.* 2, *Tylostomeae* (1906) 14.

*Tylostoma imbricatum* Pers., *Tent. dispos.* (1797) 6.

ad *Tulostoma mammosum* (Mich.) synonym, Winter, *Die Pilze* 1 (1883) 892.

ad *Tylostoma mammosum* (Mich.) variet., *Sacc. Syll. Fung.* 7 (1888) 61.

*Tulostoma pedunculatum* Linn. var.  $\beta$  *longipes* Czern., Bull. Soc. Imp. nat. de Moscou 18 (1845) 145.

*Tylostoma Barlae* Quélet, Bull. Ass. France, p. 17.

*Tulostoma mammosum* Fr. var. *squamosum* (Gmel. ex Pers.) Fr., Sacc. Syll. Fung. 7 (1888) 61..

*Peridium* 6–8 mm., dark reddish brown, depressed globose. *Exoperidium* dark, rough, sometimes separating entirely from the endoperidium. *Endoperidium* smooth, thin, tough, membranaceous, pale or leather yellow. *Mouth* small, tubular, round, same colour as remainder of endoperidium or sometimes paler. *Stalk* long, round, dark, covered with large reddish-brown scales which are often caducous. *Gleba* rusty brown. *Capillitium* hyaline, strongly branched, very thick-walled, frequently septate, swollen at septa (sec. Lloyd l.c.), not septate (sec. Hollós l.c.), 4–8  $\mu$  diam. *Spores* pale yellow, verrucose, 5–6  $\mu$  diam. (Description ex Lloyd and Hollós.)

*Habitat* : on ground.

*Distribution* : South Africa ; Europe.

*Specimen examined* : Queenstown, C.P., Feb. 1931, *F. B. Pope* (N. J. G. Smith's collections and Kew).

*Specimen not seen* : " Karroo, nr. Melk rivier, Somerset West, Cape ", *MacOwan*, Kew (as *T. mammosum* var. *squamosum*).

The Queenstown specimen was identified, while at Kew, by N. J. G. Smith, who based his findings mainly on descriptions given by Lloyd (l.c.) and Hollós (l.c.). Prof. Smith kindly supplied the author with a specimen, remarking that it probably did not show all its original features. His notes on the collection are to the effect that in some specimens the peridia are very bleached and that in some stems the scales are rubbed off, but in specimens where these are present, the stems are very scaly. The details of the specimen examined are as follows: *Peridium* 8 mm. diam. *Endoperidium* bleached, with fragments of umber-coloured exoperidium present, especially in the basal region. *Mouth* shortly tubular, even. *Stalk* 15  $\times$  1.5 mm., slightly bulbous, brown, irregularly sulcate, scales lacking. *Capillitium* threads frequently branched, often with an expanded area at the point of junction, occasionally septate, swollen and deeper coloured at the septa. *Spores* globose, fairly strongly verrucose, 4–6.8  $\mu$  diam. The specimen, as it is at present, shows a strong resemblance to specimens here identified as *T. albicans*.

In connection with the MacOwan specimen at Kew, " Somerset West " is evidently an error ; there is a Melk Rivier in the Graaff Reinet district.

The distinguishing feature of this species is the very scaly stalk. Since the scales, however, are easily rubbed off, the identification of an old specimen might easily present difficulties.

#### 8. *Tulostoma lacticeps* Bresadola.

*Annales Mycologici* 18 (1920) 54.

*Sacc. Syll. Fung.* 23 (1925) 591.

*Exoperidium* furfuraceous above, soon deciduous, persistent at the tomentose membranaceous base. *Endoperidium* smooth, subglobose, papyraceous, milky white, 1–1.5 cm. diam. *Mouth* mammosc, white, not coloured, about 1 mm. high. *Stalk* hollow, pale or bright straw-coloured, covered with broad scales formed by the split epidermis, subequal, slightly compressed, the apex inserted into the depression of the peridium, 3–4 cm. long, about 4 mm. thick. *Spores* globose or subglobose, yellow, verrucose or shortly

verrucose or shortly aculeate, 4.5-5.5  $\mu$  diam. or  $6 \times 5 \mu$ . *Capillitium* threads hyaline, thickly or somewhat thickly tunicated, septate, often thickened at the septa, 2-6  $\mu$  (Bresadola l.c.).

*Habitat* : on ground.

*Distribution* : South Africa.

*South African Record* : Mocambique, Torrend 420.

Bresadola observes that this species is near *Tulostoma Mollerianii*, but is well distinguished by the white colour of the endoperidium, the more coarsely verrucose spores and the straighter hyphae of the gleba.

**9. *Tulostoma cyclophorum* Lloyd, [Plate LXVI, fig. 2.]**

*Mycological Writings* 2, *Tylostomeae* (1906) 25, plate 85.

*Sacc. Syll. Fung.* 21 (1912) 476; *Verwoerd, Ann. Univ. Stell.* 3 (1925) 13; *van der Byl, Trans. Roy. Soc. S. Africa* 9 (1921) 185.

*Peridium* depressed globose, 6-20 mm. wide, 7-12 mm. high, with a basal crown of brown, pointed, membranaceous scales. *Exoperidium* pale brown, or darker due to the presence of sand particles, thin, brittle, disappearing almost entirely except for a shallow, disc-like structure at the base of the endoperidium. *Endoperidium* pale ochraceous to buff (Pinkish Buff to Cinnamon Buff) obscurely furfuraceous, becoming nearly smooth. *Mouth* round or more often elliptical, raised, shield-shaped, with a lacerated fibrillose or woolly margin, which is sometimes outlined by a groove. *Stem* 1.4-5 cm. long, 2-4.6 mm. thick, fistulose, slender, dark, more or less equal except for the basal mycelial bulb; the cortex splitting longitudinally into strips, but persisting around the base of the endoperidium as a lacerated collar of brown, membranaceous, pointed scales. *Gleba* rusty brown. *Capillitium* threads closely interwoven, hyaline, tinted, pale brown or occasionally dark brown, varying in thickness from very slender to 12  $\mu$  diam., rather freely branched, sparsely septate, often dark and swollen to almost bulbous at the straight or oblique septa; sometimes very thick-walled. *Spores* globose or subglobose, finely verrucose, pale or yellowish brown, 3.4-5  $\mu$ .

*Habitat* : in sandy ground.

*Distribution* : South Africa.

*Specimens examined* : Grahamstown, March 1931, *N. J. G. Smith*, 25898, Kew; Matatiele, C.P., Oct. 1933, *Gideon Joubert*, 27290; Stellenbosch, May 1923, *F. Eyles* (Stell. 78; v. d. Byl 1136; Lloyd Myc. Coll. 28934, 28958); Knysna, *A. V. Duthie* 57, 58, 146, 157, 31322 (v. d. Byl 1085), 31323, 31370, 31376 (Lloyd Myc. Coll. 4494, 14279, 14280, 24519, 24520, 30832, 54734); Stellenbosch, *A. V. Duthie* (E. L. Stephens 73).

*Specimens not seen* : Wellington, *B. Stoneman* (Lloyd Myc. Coll. 4495, Type); locality, unknown, P. v. d. Byl (Lloyd Myc. Coll. 28934, 28958); *C. A. O'Connor* (Lloyd Myc. Coll. 30933); *E. L. Stephens* 220.

According to Lloyd (l.c.) this plant resembles *Tulostoma Rickii* in general appearance and particularly the cortical collar at the base of the peridium. It is distinguished from other species by its mouth, the cortical collar and the capillitium threads.

**10. *Tulostoma transvaalii* Lloyd, [Plate LXVII, fig. 2.]**

*Mycological Writings* 6, *Myc. Notes* 65 (1921) 1047, Plate 179, fig. 1940.

*Verwoerd, Ann. Univ. Stell.* 3 (1925) 13.

*Peridium* depressed globose to pulvinate, 0.5-1.7 cm. high, 0.8-2.4 cm. wide. *Exoperidium* umber, apically finely warted, falling away in patches from the upper part,

but persistent in the basal half. *Endoperidium* buff to light tan, pubescent then smooth. *Mouth* round to elliptic, more or less a torn aperture, indefinite to shortly mammose with a fimbriate margin, concolorous. *Stem* 0.8–1.5 cm. long, 2–8 mm. thick, with an abrupt mycelial bulb at the base, typically short and proportionally thick, umber brown, scaly. *Gleba* ferruginous. *Capillitium* threads hyaline to tinted, up to thicker than spores but often thinner, sparsely septate and branched. *Spores* globose, brown, strongly aculeate, 6–7  $\mu$ .

*Habitat* : in sandy soil.

*Distribution* : South Africa.

*Specimens examined* : one collection only of ten specimens, Warmbaths, Transvaal, Feb. 1917, V. A. Putterill (Lloyd Myc. Coll. 22713, Type) 11692.

This species is characterised by its obese appearance, brown, warty exoperidium and short, mammose mouth with fimbriate border.

#### 11. *Tulostoma obesum* Cooke et Ellis.

*Grevillea* 6 (1878) 82.

G. H. Cunningham, Gastero. (1944) 186; Lloyd, Myc. Writ. 2, Tylostomeae (1906) 23.

*Tylostoma poculatum* White, Bull. Torrey Bot. Club 28 (1901) 431.

*T. gracile* White, l.c., p. 430.

*T. kansense* Peck ex White l.c.

*T. Lloydii* Bres., Ann. Myc. 2 (1904) 423.

*Peridium* depressed globose, to 10 mm. tall, 12 mm. diam. *Exoperidium* thin and fragile, breaking away completely save at the persistent basal portion. *Endoperidium* fawn coloured or dingy white, papyraceous. *Mouth* papillate, surrounded by an orbicular, fibrillose zone which may attain a diameter of 3 mm. *Stem* 2–3 cm. long, 3–5 mm. thick, tan coloured, sulcate, striate, equal, stuffed, slightly bulbous at the base. *Gleba* ferruginous. *Capillitium* threads tinted or hyaline, sparingly branched, slightly swollen at the septa. *Spores* globose or subglobose, frequently subangular, 4–6  $\mu$  diam., briefly pedicelled, episporous pallid, ferruginous, 1  $\mu$  thick, smooth. (Description after Cunningham l.c.)

*Habitat* : on soil.

*Distribution* : South Africa; North America; Australia; New Zealand.

*South African Record* : The Point, Knysna, C.P., A. V. Duthie 25. det. Lloyd as *T. poculatum* White.

This specimen was not included amongst others donated by Dr. Duthie to the National Herbarium, nor is it amongst van der Byl's collections.

According to Cunningham (l.c.) the distinguishing features of this species are the fimbriate mouth and smooth spores.

Cunningham, following Lloyd, originally called this species *T. poculatum* (Gastero., 1925 : 254) but Coker and Couch (Gastero., 1928 : 155) subsequently pointed out that the latter cannot be separated from *T. obesum* which antedates it. If, however, this species is the same as *T. volvulatum*, as Hollós seems to think, then the latter is the earlier name. Coker and Couch and Lloyd, however, treat them as two separate species, on the grounds

that in *T. volvulatum* the edge of the mouth is not composed of a fibrous wall, while in *T. obesum* it is surrounded by a slightly elevated fibrous mat. No named plants of any of these species have been available for examination.

12. **Tulostoma MacOwani** Bresadola.

Petri in *Annales Mycologici* 2 (1904) 429, Plate 6, figs. 13-14.

Sacc. Syll. Fung. 21 (1912) 475.

*Peridium* globose, papyraceous, smooth, surrounded by a dark tomentose zone at the base, deeply umbilicate, 1-1.5 cm. diam. *Mouth* fimbriate, plane. *Stalk* sub-woody, hollow, longitudinally sulcate-striate, brown, more or less smooth, scarcely lacerated, 1.5-4 cm. long, 2-3 mm. thick. *Spores* subglobose, often irregular, golden yellow, minutely and sparsely verrucose, 5.5-7  $\mu$  diam. or 5-7  $\times$  4-5  $\mu$ . *Capillitium* threads tinted yellow, slightly tunicated, not easily breaking into sections, 5-7  $\mu$  thick, thickened and ochraceous at the extremities. (ex *Annales Mycologici*, l.c.)

*Habitat* : on ground.

*Distribution* : South Africa.

*South African Record* : Cape Province, MacOwan, Kew.

The type specimen has not been seen by the writer. According to Petri (l.c.) *Tulostoma MacOwani* resembles *T. fimbriatum* Fr. in outward appearance, but the capillitium threads are like those of *T. granulosum* Lév.

13. **Tulostoma australianum** Lloyd, [Plate LXVII, fig. 1.]

*Mycological Writings* 2, *Tylostomeae* (1906) 20.

G. H. Cunningham, *Gastero.* (1944) 189.

*Peridium* 11-13 mm. wide, 5-8 mm. high, depressed globose. *Exoperidium* rough, mixed with sand particles, falling off irregularly from the upper part, usually persistent at base. *Endoperidium* whitish, smooth, tough, membranous. *Mouth* an irregular torn aperture. *Stalk* fistulose, dark or pale brown, up to 3.5 cm. long and 3 mm. thick, cortex splitting irregularly, giving stem a somewhat scaly appearance, enlarged at base. *Gleba* rusty brown. *Capillitium* threads hyaline to tinted, thick-walled, varying in thickness up to 7  $\mu$ , rather sparingly branched, sparsely septate, somewhat swollen at septa. *Spores* globose to subglobose, relatively smooth (in lacto-phenol, finely verrucose when dry) pale to dark brown, 4-6  $\mu$  diam.

*Habitat* : in sandy ground.

*Distribution* : South Africa ; Australia.

*Specimens examined* : Fauresmith, O.F.S., June 1935, *M. Henrici*, 28311 ; Fort Hare, Alice, C.P., Aug. 1934, *W. H. Giffen*, 27501.

This species is recognised by its irregular, torn mouth and relatively smooth spores. The description given agrees with that of Cunningham (l.c.) in the large size of the spores and scaly appearance of stem, but with that of Lloyd (l.c.) in the shorter stem and relatively smooth spores. No named specimens of the species were available for comparison and as the description was made from comparatively few individuals, it may have to be emended later.

Cunningham (l.c.) considers that *Tulostoma Readeri* and *T. granulosum* are synonyms of *T. australianum* but as, according to Lloyd, both of these apparently have strongly

verrucose spores, they are probably not the same as the South African plant, which has comparatively smooth spores; smooth in lacto-phenol but finely and sparsely verrucose when examined dry.

14. *Tulostoma adherens* Lloyd.

*Mycological Writings* 7 (1923) 1199, Pl. 245, fig. 2457.

*Peridium* 2·2-2·8 cm. wide, 1·5-2 cm. high, depressed globose, with an irregular, substantial collar at the base. *Exoperidium* dark grey to blackish, mixed with sand, falling off either in small irregular fragments or almost entirely from the upper part, persistent at base. *Endoperidium* dirty white, smooth or patchy due to dark scattered remnants of the exoperidium. *Mouth* round to elliptical, almost plane, entire. *Stalk* fistulose, tough, sulcate-striate, becoming lacerated, dingy white or pale ochraceous, with a mycelial bulb at the base. *Gleba* rusty brown. *Capillitium* threads hyaline or tinted, very variable in thickness, from 1-8·5  $\mu$  diam., straight or wavy, thick threads often irregularly thickened, sparingly branched, very sparsely septate. *Spores* ochraceous, finely but sparsely echinulate, globose or subglobose, 4-6·8  $\mu$  diam., common size about 5  $\mu$ .

*Habitat*: in sandy soil.

*Distribution*: South Africa; Australia.

*Specimens examined*: Stellenbosch Flats, June 1928, *A. V. Duthie* (E. L. Stephens 66) 31505.

In view of the fact that the above collection consists of only three specimens and these do not agree with any of the very few named specimens available, great difficulty has been experienced in placing them. Until further specimens are collected and facilities are available for comparison with overseas specimens, it has been decided tentatively to refer the South African plants to *Tulostoma adherens*, with the description of which it seems most closely to agree. The distinguishing features of the plants in question are the relatively large size, the nearly plane mouth and, in two specimens, the irregularly adhering exoperidium. It differs from descriptions of *T. adherens* in having a pale instead of a brown peridium and in its larger size.

**Doubtful Species.**

***Tulostoma angolense* Welwitsch et Currey.**

*Transactions Linnean Society* 26 (1868) 290, Pl. 20, f. 10-11.

*Sacc. Syll. Fung.* 7 (1888) 64.

Entire plant 4-4·5 cm. high. *Peridium* white, subglobose. *Mouth* imperfect. *Stipe* narrowing gradually from the apex towards the base. *Capillitium* ferruginous. *Spores* concolorous, subglobose or subelliptic, 5  $\mu$  diam. (Description ex *Saccardo*, l.c.)

*Habitat*: on sandy soil and on wood.

*Distribution*: South Africa.

*South African Records*: on sand hills covered with *Euphorbia bellica* Hiern, nr. Mossamedes, Angola, *Welwitsch* 147; on decaying wood, S. Africa, *MacOwan*, Kew.

With regard to the Angola specimen, the authors (l.c.) observe that this species is possibly not distinct from *Tulostoma Meyenianum* Klotzsch [synonym of *Chlamydopus Meyenianus* (Kl.) Lloyd] but is much smaller than that species, and differs in not having the longitudinal furrows on the stem.

## 2. BATARREA Persoon.

*Synopsis Methodica Fungorum* (1801) 129.

*Dendromyces* Libr., *Beschr. neu entd. Polzes* (1814) fig. 1.

*Sphaericeps* Welw. & Curr., *Trans. Linn. Soc.* 26 (1870) 290.

Type species : *Batarrea phalloides* (Dicks.) Pers.

Plants originally globose or pyriform, enclosed in a volva, developing in much the same way as a phalloid, finally emerging as a stalked, campanulate peridium with the remains of the volva surrounding the base of the stem. Peridium of two layers :—the exoperidium consisting of the remains of the volva, thin and usually mixed with sand particles and the endoperidium hemispherical, with a concave or almost plane base, smooth, thin, coriaceous, whitish to ochraceous, dehiscing circumscissilely, except in *B. Diguetti*, at the junction of the base with the hemispherical upper portion, the latter resembling a cap as it falls off in one piece. Stalk usually long, squamose, seated in a coriaceous to woody volva. Gleba rusty brown, compact then pulverulent, often completely disintegrating and falling away from the base of the endoperidium. Capillitium threads of two types—simple hyaline threads occurring singly or longitudinally compacted together into a hyaline sheet of tissue, and elaters or annulated cells with annular or spiral thickenings. Spores globose and, with ordinary high power magnification, seemingly thick-walled and finely verrucose. “Basidia bearing apically 1-4 spores on long sterigmata.”

According to Maublanc and Malençon (*Bull. Soc. Myc. France* 46, 1930 : 53), the spores are double-walled, the outer wall  $0.5 \mu$  thick, coloured and punctiform, the inner hyaline and  $1 \mu$  thick when mature, the verrucose appearance being due to thickenings caused by the intersection of the arms of the mesh surrounding the perforations.

All *Batarrea* plants are originally subterranean, usually occurring in sand or sandy soil, becoming at least partially aerial when mature. The campanulate shape of the peridium, the circumscissile dehiscence, the elaters and the nature of the spore wall are the characteristic features of the genus. According to Cunningham (*Gastero.* 1944 : 192) only three of the fifteen described species can be recognised with certainty—*B. Stevenii*. *B. Diguetti* and *B. phalloides*. Of these the first two occur in South Africa; *B. phalloides* has been recorded, but no young specimens of this plant have been available for study.

The spelling of the name of the genus has undergone many changes. Persoon originally named the fungus after Antonio Battarra, spelling it *Batarrea*. Since then it has been spelled in various ways by different mycologists—*Battarea* by Beauvais, *Battarrea* by Maublanc and Malençon and Cunningham and *Battarrea* by Saccardo, Fischer, Lloyd, Coker and Couch and Rea. Fries used the latter spelling in the first place, but later reverted to Persoon's spelling, which is used here.

## Key to the species.

Volva gelatinous; plants comparatively small..... 1. ***B. phalloides***.

Volva not gelatinous; plants larger.

Endoperidium caducous, dehiscing circumscissilely..... 2. ***B. Stevenii***.

Endoperidium persistent, dehiscing by apertures..... 3. ***B. Diguetti***.

1. ***Batarrea phalloides*** (Dickson) Persoon.

*Synopsis Methodica Fungorum* (1801) 129.

Berkeley, *Hooker's London Journ. Bot.* 2 (1843) 517.

Sacc. *Syll. Fung.* 7 (1888) 66; Rea, *Brit. Basid.* (1922) 53; Hollós, *Gastero. Ung.* (1904) 38; Verwoerd, *Ann. Univ. Stell.* 3 (1925) 13.

Peridium campanulate, with hemispherical upper portion and concave to almost plane base, up to 3.5 cm. diam. Exoperidium whitish, represented by the remains of the volva

left when the latter splits to release the developing stalked peridium. *Endoperidium* enclosing the gleba, membranaceous, becoming tough and coriaceous, splitting circumscissilely at the junction of the upper hemispherical portion with the concave base, the former falling off in one piece like a cap or calyptra. *Stalk* 0.5–1 cm. thick, 14–19 cm. long, rusty brown, attenuated at both ends, woody; cortex splitting into linear, membranaceous scales, which are often pendulous in the upper part and erect in the lower. Stalk hollow, or stuffed when mature with long silky threads, filled when immature with mucilaginous substance, seated in the base of the remains of the volva. *Volva* white, two-layered, originally soft, with mucilaginous substance between the two layers, becoming tough and hard. *Gleba* rusty brown. *Capillitium* threads of two kinds, simple hyaline threads occurring singly or longitudinally compacted together into a shred-like tissue, and annulated threads or elaters with annular or spiral thickenings,  $62-80 \times 8 \mu$ . Spores ochraceous brown, obtusely verrucose, globose, often with a hyaline apiculus,  $6 \mu$  diam.

*Habitat* : in sandy places and in vegetable debris.

*Distribution* : ? South Africa; North and South America; Asia; Australia; Europe.

*South African Records* : on ground, Uitenhage, C.P., Zeyher 114; on humus ground, Kalk Bay, C.P., M. Levyns (v. d. Byl, 1305, det. v. d. Byl).

*Batarrea phalloides* is distinguished from other species mainly on the nature of the volva, which is gelatinous in young plants, whereas in other species it is originally fleshy, never gelatinous. Neither of the two South African collections has been seen. Zeyher's specimen is probably in the Herb. Berkeley at Kew; Mrs. Levyns' specimens were not found amongst v. d. Byl's collections.

Hollós considers that *B. phalloides* is the only recognisable species, but Cunningham is followed in separating *B. Stevenii* and *B. Digiueti* for reasons indicated later. Verwoerd (l.c.) makes no mention of the nature of the volva in his description. He probably based his identification on the interpretation of Hollós, in which case the Levyns' specimen may quite likely be *B. Stevenii*.

2. **Batarrea Stevenii** (Liboschitz) Fries, [Plate LXIX; LXX, fig 2.]

*Systema Mycologicum* 3 (1829) 7.

Sacc. Syll. Fung. 7 (1888) 66; G. H. Cunningham, Gastero. (1944) 192.

*Dendromyces Stevenii* Lob., Beschr. neu entd. Pilzes (1814).

*Batarrea gaudichaudii* Mont., Ann. Sci. Nat. Ser. II, 2 (1834) 76.

*Sphaericeps lignipes* Welw. et Curr., Trans. Linn. Soc. 26 (1870) 290.

*Battarrea guicciardiniana* Ces., Atti d. R. Accad. Sci. e Nat. 7 (1875) 1.

*B. Muelleri* Kalchbr. ex. Kalchbr. & Cooke, Grev. 9 (1880) 3.

*B. tepperiana* Ludw., Bot. Centralbl., 43 (1890) 7.

*B. laciniata* Underw., ex. White, Bull. Torrey Bot. Club 28 (1901) 439.

? *B. levispora* Mass., Kew Bull. (1901) 152; Sacc. Syll. Fung. 7 (1888) 24.

*Peridium* campanulate, with pulvinate upper portion and concave base, 2.4–7 cm. wide, 2–5 cm. high. *Exoperidium* whitish, fragile, soon disappearing. *Endoperidium* smooth, glossy, rough, membranaceous, white or ochraceous, dehiscing by circumscissile rupture at the junction of the upper part with the concave base, the former falling off in one piece resembling a cap, leaving the mass of the gleba attached to the concave base, which is cream, greyish or buff-coloured, thin, woody, entire or lacerated around the edge, shining and smooth underneath and shallowly rugulose above. *Stalk* 11–40 cm. long, 0.7–3 cm. thick, dove grey, ochraceous to drab, cylindrical or oval, attenuated towards the base,

fibrous woody, hollow, deeply sulcate, moderately to strongly squamulose, due to the longitudinal splitting of the cortex into thin to broad, linear, membranous scales, which may be either erect or pendulous; seated in a non-gelatinous, irregularly split volva. *Volva* up to 8 cm. wide and high, of three layers—the outer whitish, coriaceous woody and rough with sand particles, the middle layer rusty brown and spongy fibrous and the inner ochraceous, woody, surrounding the base of the stem-like a sheath. *Gleba* rusty brown, (Verona Brown), greyish brown, at first compact, later pulverulent and disintegrating, leaving the base of the endoperidium completely bare. *Capillitium* originally attached to all parts of the endoperidium, of two types—simple, hyaline threads occurring singly or as shreds, and thicker, hyaline elaters, which are cylindrical or fusiform, simple or less frequently once forked, straight, wavy or angled, with darker annular or spiral thickenings. *Spores* globose, subglobose or slightly irregular, thick-walled, seemingly finely verrucose,  $4.5-7 \mu$  diam.

*Habitat* : solitary or very occasionally caespitose, usually occurring in sand or sandy soil in exposed or shaded positions.

*Distribution* : South Africa; North and South America; Asia; Australia; Europe.

*Specimens examined* : Kaapmuiden, Tvl., *H. A. Wager*, 7735; Koffiefontein, O.F.S., March 1916, *Schulz*, 9535; Rouxville, June 1917, *J. Wickens*, 11294; Postmasburg, Jan. 1920, *M. Wilman*, 12517; ? Willowmore, C.P., Dec. 1919, *Dr. Schonland*, 12518; Malcomes, Knapdaar, C.P., April 1924, *Gideon Joubert*, 18112; in sand dunes in scrub, Lourenco Marques, Moçambique, *J. van Nouhuys*, 25936; in deep sand under Acacias, Saltpan, N. Tvl., *H. Schweickerdt*, 26622; on turf, Sekukuni, Lydenburg Distr., May 1935, *W. G. Barnard* 391, 28517; 372, 28261 (said to be medicinal, native name MOKOTATMPJA); on dry black vlei soil, Fauresmith, O.F.S., March 1936, *J. Pont*, 28584; Knysna, April 1939, *A. M. Bottomley* 30743; Knysna, Jan. 1920, *A. V. Duthie* 134, 31362, as *B. phalloides*; sand dunes, Pringle's Bay, Dec. 1935, *R. H. Compton* (E. L. Stephens 461); Bantry Bay, *V. A. Putterill*, 28669; foothills of Langebergen, Riversdale, C.P., May 1927, *R. Marloth*, 13437, as *Tulostoma*.

*Specimens not seen* : on banks of Caroca River nr. Cabo Negro, Mossamedes, *Welwitsch* 150, as *Sphaericeps lignipes* *Welw. et Curr.*

The South African plants assigned to this species are of two more or less distinct types—a slender, grey, small-headed plant of the *Batarrea tepperiana* type, in which the gleba completely disintegrates and falls away and in which the volva is consistently lacking, and a larger, more robust type with large volva present, longer elaters and somewhat larger spores, and in which, in all specimens seen, the gleba remains compact if somewhat pulverulent for a considerable time after the endoperidium has fallen off. Unfortunately the volva, on the nature of which *B. Stevenii* is separated from *B. phalloides*, is lacking in every specimen of the smaller type, so that it is impossible to be absolutely sure that these plants are not *B. phalloides*; but since the latter species is said to be known with certainty only from Britain and France, such plants are referred to *B. Stevenii* until such time as complete young specimens are found.

### 3. *Batarrea Digueti* Patouillard et Hariot, [Plate LXX, fig. 1.]

*Journal de Botanique* 10 (1896) 251, tab. 2.

*Sacc. Syll. Fung.* 14 (1899) 259; *White*, *Tylostomaceae*, *Bull. Torrey Bot. Club* 28 (1901) 440; *Lloyd*, *Myc. Writ.* 2, *Tylostomeae* (1906) 7, Pl. 75.

*Battarrea Griffithsii* *Underwood*, *White* l.c.

*Peridium* 2-3.5 cm. wide, 1-2 cm. high, pulvinate, with a concave base centrally seated on the slightly enlarged apex of the stem, the junction between the upper rounded portion

and the concave base clearly demarcated by a narrow, protruding, membranaceous margin. *Exoperidium* thin, chalky, brittle, white, more or less smooth, mainly persistent on the upper part. *Endoperidium* whitish to pale buff, very smooth, like kid to the touch, not dehiscing circumscissilely, like other species, at the junction of the upper and lower parts, but probably by several irregular, scattered apertures which develop at maturity. *Stalk* whitish or cream, 15-20 cm. long, 8-10 mm. thick, cylindrical, hollow, deeply sulcate, attenuated towards the base, almost smooth or squamose, with linear, obscurely imbricate scales, concolorous, seated in a volva. *Volva* of three layers, the outer coriaceous, rigid, the middle composed of 10-20 membranaceous, fibrous, brownish layers and the inner 1-1.5 mm. thick, woody, closely surrounding the stem like a sheath at about a third of its height. *Gleba* rusty brown, pulverulent. *Capillitium* of two types, simple, hyaline threads of varying thickness from filiform to 7  $\mu$  diam., occurring either singly or longitudinally compacted together to form a shred-like tissue, and coarser, hyaline elaters up to 136  $\mu$  long and 3-4.7  $\mu$  diam., simple or forked, wavy, nearly straight or angled and with darker annular or spiral thickenings. *Spores* globose, broadly oval, usually thick-walled, obscurely verrucose (cf. remarks on genus) ochraceous brown, sometimes shortly pedicelled, 4-6.8  $\mu$ . (Description ex Patouillard et Hariot, l.c.)

*Habitat*: in "barren, rocky soil" and on termite mounds.

*Distribution*: South Africa; North America.

*Specimens examined*: on termite heap, Dongola Reserve nr. Messina, N. Tyl., Aug. 1925, I. B. Pole Evans, 20459.

This specimen has a peridium 3 cm. wide, 2 cm. high and a stipe (broken off) 11 cm. long, 9 mm. thick, deeply sulcate and only slightly lacerated here and there.

The species is distinguished by its persistent endoperidium and non-circumscissile dehiscence. It is thought to dehise by apertures which develop late, but it is possible that the indications of apertures, seen in the South African specimen, may be the beginning of general disintegration.

According to Cunningham (Gastero. 1944 : 192) *B. Diguetti* is confined to North America, but there seems little doubt that the South African plant here described in this species.

### 3. PHELLORINA Berkeley.

London Journal of Botany 2 (1843) 421.

emended Kalchbrenner & Cooke, Grev. 9 (1880) 3.

Sacc. Syll. Fung. 7 (1888) 145; G. H. Cunningham, Gastero. (1944) 193; Verwoerd, Ann. Univ. Stell. 3 (1925) 14.

*Xylopodium* Mont., Ann. Sci. Nat. ser. III, 4 (1845) 364.

*Areolaria* Kalchbr., Ertek. Term. 8 (1884) 8.

*Cypellomyces* Speg., Anal. Mus. nac. Buenos Aires 9 (1906) 25.

*Thype Species*: *Phellorina inquinans* Berk.

Plants white when fresh, consisting of a stalked peridium in which the exoperidium and the endoperidium are continuous with the outer layers of the stalk. Exoperidium typically covered with scales or warts. Endoperidium a thin, tough, membranous structure, dehiscing by the disintegration and falling away of the apical part of the peridium; the lower part persistent as a cup-shaped structure. Stalk thick, woolly, typically squamose. Gleba

finally rusty brown, becoming pulverulent and falling away. *Capillitium* threads hyaline, shred-like. Spores globose, pale ochraceous, finely verrucose. Basidia arranged in persistent fascicles, each basidium bearing 1-4 spores, which are sessile on short sterigmata.

According to Cunningham, the genus has probably only four species, *Phellorina inquinans*, *P. strobilina*, *P. macrospora* Lloyd and *P. argentensis* (Speg.) Fr. Of these only the first two are found in South Africa. *P. macrospora* is confined to North America and *P. argentensis* to South America.

#### Key to the South African Species.

Exoperidium covered with flat, overlapping scales.....	<i>P. inquinans.</i>
Exoperidium covered with zoned pyramidal warts.....	<i>P. strobilina.</i>

#### 1. *Phellorina inquinans* Berkeley, [Plate LXXI.]

*London Journal of Botany* 2 (1843) 421.

*Sacc. Syll. Fung.* 7 (1888) 145; *Verwoerd, Ann. Univ. Stell.* 3 (1925) 14; *G. H. Cunningham, Gastero.* (1944) 193.

*Xyloporium Delastrei* Mont., *Ann. Sci. Nat. Ser. III*, 4 (1845) 366.

*X. australe* Berk., *Journ. Linn. Soc.* 13 (1872) 171.

*X. Aitchisonii* Cooke et Mass. ex Cooke, *Grev.* 16 (1887) 69.

*Phellorina californica* Peck, 42nd Rep. New York State Mus. (1890) 35.

*P. Saharae* Pat., *Bull. Soc. Myc. France* 12 (1896) 151.

*P. Delastrei* (Mont.) Fisch., *Nat. Pflanz.* 1, 1\*\* (1900) 334.

*P. australis* (Berk.) Lloyd, *Myc. Writ. I, Lyc. Austr.* (1905) 11.

? *Xyloporium bonaciinae* Speg.

? *Phellorina leptoderma* Pat.

Plants 8-23 cm. high. *Peridium* pyriform, 4-9 cm. high, 5-9 cm. wide. *Exoperidium* cream to pale ochraceous, continuous with the stalk, in typical plants covered with large, coriaceous, downward overlapping scales. *Endoperidium* becoming membranous, smooth, shining, whitish to leaden coloured, subglobose to oval, continuous with the stem, dehiscing by the irregular breaking away of the apical portion, or by splitting circumseissilely above the middle; the upper part then disintegrating and falling away, leaving a stalked, cupulate structure with a lacerated margin, exposing the gleba. *Stalk* 5-14 cm. long, 1.5-2.7 cm. thick, whitish, cream or becoming pale brown on exposure, almost smooth, longitudinally striate, with few to many large, erect scales at intervals or overlapping one another, solid, slightly tapering towards the base which may or may not be bulbous. *Gleba* cream to ochraceous, becoming cinnamon to rusty brown (Ochraceous Tawny), compact at first, becoming pulverulent. *Capillitium* threads scanty, more in the nature of hyaline shreds than individual threads. Spores globose to subglobose, pale yellowish brown, finely verrucose, 4.5-8.5  $\mu$  diam.

*Habitat* : usually in sandy soil, solitary.

*Distribution* : South and North Africa; North America; Asia; Australia.

*Specimens examined* : Knapdaar, Burghersdorp Distr., 1918, *Gideon Joubert*, 11541; April 1924, 18111; Nov. 1935, 28519; Nov. 1936, 28739; Springbok Flats, Tvl., May 1912, *Rev. N. Roberts*, 2277; Kroonstad, O.F.S., Sept. 1929, *J. W. Pont*, 24934; Winburg, O.F.S., May 1941, *E. Haslem*, 33272; Kingwilliamstown, C.P., June 1932, *F. M. Leighton*, 26409; Barkly West Distr., C.P., May 1936, *J. P. H. Acocks* 335, 28633; Clanwilliam, *A. V. Duthie* 203, 31398.

*Specimens not seen* : Uitenhage, Zeyher 98, Type ; Vaal River, Kimberley, Pearson Kew.

Typical specimens of this species are recognised by the pyriform peridium covered with large, smooth, flat, downward overlapping scales. In less typical plants (Nos. 24934, 18111, 11541, 2277) the peridium is more or less areolated with flat wart-like thickenings between the divisions. This form is transitional between *P. inquinans* and *P. strobilina*.

**2. *Phellorina strobilina* Kalchbrenner, [Plate LXXII.]**

ex Kalchbrenner & Cooke, Grevillea 9 (1880) 4.

Sacc. Syll. Fung. 17 (1905) 239 ; Verwoerd, Ann. Univ. Stell. 3 (1925) 14.

G. H. Cunningham, Gastero. (1944) 194.

*Scleroderma strobilina* Kalchbr. ex Thuem., Grev. 4 (1875) 74.

*Phellorina squamosa* Kalchbr. et MacOwan in Kalchbrenner, Grev. 10 (1882) 109.

*Areolaria strobilina* Kalchbr., Ertek. Term. 8 (1884) 8.

*Xylopodium ochroleucum* Cooke et Massee ex Cooke, Grev. 15 (1887) 95.

Plants 6.5-15 cm. high. *Peridium* 3.5-6 cm. high, 2.5-7.5 cm. wide, depressed globose or less often subglobose. *Exoperidium* pure white at first, becoming dirty white, pale ochraceous or pale brown, covered with zoned, usually angular, pyramidal warts which are up to 1.5 cm. high and 2.5 cm. broad at the more or less angular, expanded base. *Endoperidium* whitish to leaden coloured, tough, membranaceous, smooth, shining. *Stalk* 5-12 x 1-2 cm., white, cream, ochraceous, thick, solid, woody ; smooth, deeply striate-sulcate or sparsely or thickly covered with large erect scales ; straight, curved or crooked, equal or attenuated towards the base, bulbous or not. *Gleba* finally rusty brown, compact, becoming pulverulent and falling away. *Capillitium* threads scanty, hyaline, shred-like. *Spores* globose, finely verrucose, pale ochraceous brown, 4.5-7  $\mu$ , average size rather smaller than in *P. inquinans*.

*Habitat* : sand, sandy soil, heavy black turf ; solitary or occasionally caespitose.

*Distribution* : South Africa ; Australia ; India.

*Specimens examined* : Rust der Winter nr. Warmbaths, Tvl., 1936, *I. B. Pole Evans*, 28645 ; Saltpan, nr. Louis Trichardt, Tvl., April 1934, *I. C. Verdoorn & H. Schweickerdt*, 27546 ; on hard red clay, Limpopo, Tvl., July 1926, *I. B. Pole Evans*, 21019 ; Brits, Tvl., April 1925, *E. Marais*, 20409 ; Glen, O.F.S., April 1921, *T. Potgieter*, 14506 ; July 1935, *J. Sellschop*, 28270 ; on cattle manure, Kroonstad, O.F.S., *J. W. Pont*, May 1929, 25342 ; Brandfort, O.F.S., April 1921, *Dr. Schonken*, 31468 ; Fauresmith, O.F.S., March 1939, *L. C. C. Liebenberg*, 33250 ; Knapdaar, Burghersdorp, C.P., April 1924, *Gideon Joubert*, 18110, 1914, 11814 ; May 1916, 9735 ; April 1919, 11854 ; Aliwal North, C.P., April 1917, *J. Wicksen*, 10137 ; Uitenhage, *MacOwan* 1095 (S.A.M. 35081) 20919 ; locality unknown, *R. Marloth*, 26620 ; Little Namaqualand, *J. P. Stokoe*, 26619 ; Winburg, O.F.S., April 1924, *M. Radloff* (v. d. Byl 1440) ; Willowmore, May 1928, *Dr. H. Brauns* (v. d. Byl 2508) ; on heavy black turf, Warmbaths, Tvl., summer 1937, *Rowland*, 28808 ; Calvinia, C.P., May 1937, *A. A. Schmidt*, 28809 ; Winburg, O.F.S., May 1941, *E. Haslem*, 33271, 33461 ; Bon Accord Dam, Pretoria Distr., April 1930, *A. Leemann*, 25434 ; Clanwilliam, C.P., *Miss Berg*, 31304 (Duthie 26) ; Fauresmith, O.F.S., *M. Henrici*, 35276.

*Specimens not seen* : Brandfort, O.F.S., *Duthie* 300 ; S. Rhodesia, *Duthie* ; Bloemfontein, *L. Verwoerd* ; Southern Rhodesia, *Duthie* 189 (Herb. Bulawayo Mus.).

This species is probably more common in South Africa than *Phellorina inquinans*. It is distinguished from the latter by the more globose shape of the peridium and particularly

by the large, projecting, zoned, pyramidal warts of the peridium. Ex description, Cunningham (l.c.) considered that *Phellorina squamosa* Kalchbr. & MacOwan is probably *P. inquinans*. The type collection of *P. squamosa*, MacOwan 1095, is definitely *P. strobilina* and not *P. inquinans* as suggested by Cunningham.

#### 4. CLAMYDOPUS Spegazzini.

Anales del Museo nacional de Buenos Aires 6 (1899) 189.

Type species : *Chlamydopus Meyenianus* (Klotzsch) Lloyd.

Plants consisting of a 2-layered peridium attached to the enlarged apex of a well-developed stem. Exoperidium rough, brittle, breaking up into fragments which fall away. Endoperidium smooth, thin, tough, membranaceous, dehiscing by an irregular apical aperture. Stem solid, enlarged at the apex, slightly attenuated towards the base and seated in a small cupulate volva. Gleba ochraceous brown, pulverulent. Capillitium threads copious, sparingly branched, sparsely septate. Spores globose, ochraceous, finely verrucose. Basida fasciculate, bearing at the apex 1-4 spores with short sterigmata.

This genus is sometimes confused with *Tulostoma*, which it superficially resembles, but from which it differs in the attachment of the stalk to the peridium and in having persistent, fasciculate basidia. It resembles *Phellorina* in having fasciculate basidia mixed with the capillitium threads, but differs in the stalk attachment and in dehiscence by a definite apical aperture.

***Chlamydopus Meyenianus* (Klotzsch) Lloyd, [Plate LXXIII.]**

Mycological Writings 1, Myc. Notes 14 (1903) 134.

G. H. Cunningham, Gastero. (1944) 195.

*Tylostoma Meyenianum* Klotzsch, Noc. Act. Caes. Leop. Carol. Nat. Cur. 19 (1843) 243

*T. maxima* Cooke et Massee ex Cooke, Grev. 15 (1887) 94.

*Chlamydopus clavatus* Speg., Anal. Mus. nac. Buenos Aires 6 (1899); Sacc. Syll. Fung. 16 (1902) 234.

*C. amblaiensis* Speg. l.c.

Peridium pulvinate to depressed globose, 3.5-4.2 cm. wide, 2.5-3 cm. high. Exoperidium dirty white to buff, rough, shell-like, brittle, breaking up into fragments which fall away entirely or leave remnants at the line of juncture with the apex of the stem. Endoperidium smooth, greyish white to buff, tough, membranaceous, dehiscing by a torn apical aperture, base attached to the enlarged apex of the stem. Stalk 8.5-12 x 1-2 cm., woody, more or less solid, concolorous with the peridium, broadly sulcate, especially in the upper part; the cortex, especially in the lower part, splitting into rings of small, scale-like fragments; expanding towards the apex, but slightly constricted where attached to the peridium, narrowing towards the base, seated in a volva. Volva 2-layered, cupulate, 1.5 cm. wide, 2 cm. high (in the only specimen in which the volva is present). Gleba ochraceous brown, pulverulent. Capillitium threads hyaline to ochraceous, sparingly branched, sparsely septate, varying in thickness up to 7  $\mu$  diam. Spores 5.2-7  $\mu$  diam., finely verrucose, pale ochraceous, attached to the fascicles of basidia.

*Habitat* : in sandy soil.

*Distribution* : North and South Africa; North and South America; Australia.

*Specimens examined* : one collection of three specimens, details of locality and collector missing, 35339.

The distinguishing features of this plant are the persistent fascicles of basidia, the volva at the base of the stem, the dehiscence of the peridium by an apical aperture and the expanded apex of the stem.

### 5. DICTYOCEPHALOS Underwood.

Bulletin of the Torrey Botanical Club 28 (1901) 441.

*Battareopsis* P. Henn., Hedwigia Beibl. 41 (1902) 212.

*Whetstonia* Lloyd, Myc. Writ. 2 (1906) 259.

Type species: *Batarrea attenuata* Peck.

Sporophore hypogeous, enclosed in a volva during early stages of growth, erumpent as maturity approaches; stipitate, stem stout, solid, becoming woody; peridium of two layers, outer (exoperidium) roughened, inner (endoperidium) coriaceous to membranaceous, seated on the expanded discoid apex of the stipe; dehiscence by the irregular breaking away of the peridium; gleba powdery, having permanent cells and persistent fascicles of basidia, true capillitium none; spores globose to subglobose, fulvous, verrucose.

#### **Dictyocephalos attenuatus** (Peck) Long & Plunkett.

Mycologia 32 (1940) 697.

*Batarrea attenuata* Peck, Bull. Torrey Bot. Club 22 (1895) 208.

*Dictyocephalos curvatus* Underwood, Bull. Torrey Bot. Club 28 (1901) 441.

*Battareopsis Artini* P. Henn., Hedw. Beibl. 41 (1902) 212.

*Whetstonia strobiliformis* Lloyd, Myc. Writ. 2 (1906) 259.

*Phellorina strobilina* as shown by Lloyd, Myc. Writ. 5 (1917) 735 (see. Long and Plunkett, l.c.).

"Sporophore 7-56 cm. tall, originating 4 to 20 cm. below the surface of the soil, often with 1-2 white cord-like roots; Sporocarp globose to subglobose, depressed, often irregular, 2-6 cm. high by 5-13 cm. broad, seated on the discoid apex of the stipe, basal portion hard, thick, with the narrow margin usually concave beneath; the *discoid apex*, when freed from the gleba, light tan to white, convex and coarsely reticulate by the boundary walls of broad shallow pits; *exoperidium* fleshy to gelatinous when young, developing horny to subcartilagenous scales with age which may be small and more or less persistent or large 4-5 sided pyramidal warts 1-2 cm. broad by 1-1.5 cm. tall, normally deciduous leaving a decided scar on the endoperidium; *endoperidium* 1-2 mm. thick, basal portion often coriaceous and persistent, upper part membranous, brittle when dessicated, dehiscing by breaking into irregular pieces which soon fall away leaving the gleba exposed; *stipe* curved, sometimes straight, 5-52 cm. tall, 2-5 cm. thick at the top, 1-4 cm. at bottom, solid (except where hollowed out by insects) terete or flattened, often deeply sulcate, usually attenuate below, subfleshy, dry, subcoriaceous to woody, context when young white, becoming Walnut Brown to Vandyke Brown with age, outer surface uneven and peeling, often with coarse, spreading or reflexed scales caused by the outer layers of the stipe cracking both transversely and longitudinally from weathering, base of stipe often pointed and becoming entirely free from the enclosing volva; volva persistent, usually cupulate to obconic, sometimes tubular,

laciniate-incised, 3-11 cm. tall by 4-8 cm. wide at top, walls 2-4 mm. thick, rupturing from 2-8 cm. below surface of soil, thereby exposing the ascending sporocarp to the dirt for this distance during elongation, walls apparently composed of three layers, inner layer a thin tissue which deliquesces into a blackish fluid just preceding and during elongation, median layer semigelatinous when young, becoming horny with age, outer layer white to tan, hard, chalky in texture; *gleba* foetid, with odour of decaying fish, Pecan Brown to Mikado Brown (after Ridgway), cellular, cell wall white, fragile, membranous, composed of a hyaline amorphous central tissue overlaid by a dense network of branching colourless to fulvous hyphae, easily fragmenting and falling away in laciniate irregular flakes and shreds, cell walls in bottom of the gleba thicker, firmer and more permanent, often persisting as broad, flattened, pointed teeth on the exposed convex surface of the glebal floor long after the gleba has disappeared; *capillitium*, free capillitium absent, but the hyphae composing the outer layers of the glebal cell walls may break loose and simulate capillitium threads; *spores* globose to subglobose, 5-7  $\mu$ , walls thin, fulvous, verrucose; *basidia* clustered, bearing 1-4 spores on the short sterigmata." (Description ex Long & Plunkett l.c.)

*Habitat*: "Growing solitary or in groups of 2-5 individuals in sandy or adobe alkaline soil, in arid or semi-arid regions."

*Distribution*: North and South Africa, North America.

*South African record*: Wankie District, Southern Rhodesia, 1916, *Albert Giese*. One specimen only, half of which is in the Lloyd Mycological Collection, Washington DC. under the name *Phellorina strobilina* and the other half in the National Museum of Southern Rhodesia at Bulawayo under the same name.

Through the courtesy of the Director of the National Museum of Southern Rhodesia, the specimen quoted above was sent to me for examination. This consists of rather less than half the plant, from which the very pulverulent gleba has become detached, with about two inches of stem. No volva is present. A comparison between this specimen and specimens of the South African plant called *Phellorina strobilina* showed no difference apart from the shape of the stem apex. In the former this is more or less flattened while in the latter it is narrowly concave, the margin widening out and continuing upwards in the shape of a wine glass to form the exo- and endo- peridium. In both cases the exoperidium is continuous with the stem which is the character on which *Phellorina* is distinguished from *Dictycephalos*. Judging therefore from the specimens examined by me, *Phellorina strobilina* as shown by Lloyd l.c., is not, as stated by Long and Plunkett l.c., considered to be a *Dictycephalos* but a *Phellorina*.

### PODAXIS Desvaux.

*Journal de Botanique* 2 (1809) 87.

*Morse, Mycologia* 25 (1933) 1; *Ed. Fischer in Nat. Pflanz.* Band 7a (1933) 116 :  
G. H. Cunningham, *Gastero*. (1944).

*Schweinitzia* Grev. *Edinburgh Phil. Journ.* 8 (1823) 257.

*Cauloglossum* Grev., *Scottish Crypt. Fl.* 1 (1823) 60.

*Podaxon* Fr., *Syst. Myc.* 3 (1829) 62.

*Chainoderma* Mass. ex Cooke, *Grev.* 19 (1890) 46.

Type species: *Podaxis pistillaris* (Linn. ex Pers.) Morse.

Plants consisting of a stalked peridium in which the stalk is prolonged to the apex of the peridium as a columella. Exoperidium smooth and polished or originally scaly.

Endoperidium comparatively thick, firm, compact, brittle, typically dehiscing at the basal margin of the peridium by splitting away from the stem, less often by longitudinal splitting of the endoperidium or by the entire peridium falling off and exposing the stipe with gleba attached. Stalk usually bulbous at the base. Gleba copious. Capillitium threads sparingly branched, sparsely septate, tinted to dark coloured, straight, wavy or spiral. Spores usually broadly oval, double-walled. Basidia in fascicles.

The characteristic features of the genus are the percurrent stem, the fasciculate basidia and the double-walled spores. It is most closely related to *Phellorina* from which it differs in having the stem prolonged as a columella to the apex of the peridium.

*Podaxon* is the name more commonly known for this genus, but *Podaxis* was the name originally given by Desvaux and according to the International Rules of Botanical Nomenclature, must take precedence. Morse (l.c.) and Cunningham are followed in recognising one species only in this genus. Some 32 different species have been described at various times, but Miss Morse, who has studied the plant very extensively, is unable to find any specific differences between them.

**Podaxis pistillaris** (Linnaeus ex Persoon) Morse, [Plate LXXIV ; LXXV ; LXXVI.]

*Mycologia* 25 (1933) 27.

G. H. Cunningham, *Gastero.* (1944) 197.

*Scleroderma pistillare* (L.) Pers., *Syn. Meth. Fung.* (1801) 150.

*S. carcinomale* (L.) Pers., l.c., p. 153.

*Podaxis senegalensis* Desv., *Journ. de Bot.* 2 (1809) 97.

*Podaxon indicus* Spreng., *Syst. Veg.* 5 (1828) 518.

*P. carcinomalis* (L. ex Pers.) Fr., *Syst. Meth. Myc.* 3 (1829) 62.

*P. calyptatus* Fr., l.c.

*P. pistillaris* (l. ex Pers.) Fr., l.c., p. 63 ; *Sacc. Syll. Fung.* 7 (1888).

*P. aegypticus* Mont., *Ann. Sci. Nat. Ser. II*, 20 (1843) 69.

*P. loandensis* Welw. et Curr., *Trans. Linn. Soc.* 26 (1850) 288.

*P. elatus* Welw. et Curr., l.c.

*P. mossamadensis* Welw. et Curr., l.c. ; *Sacc. Syll. Fung.* 11 (1895) 158.

*P. arabicus* Pat., *Bull. Soc. Myc. Fr.* 3 (1887) 122.

*Podaxis axata* (Bosc.) Mass., *Journ. Bot.* 28 (1890) 75.

*P. Farlowii* Mass., l.c., p. 77.

*P. emerici* Berk. ex Mass., l.c., p. 77.

*Chainoderma Drummondii* Mass. ex Cooke, *Grev.* 19 (1890) 46.

*Podaxon Schweinfurthii* Pat., *Bull. Soc. Myc. Fr.*, 6 (1890) 165.

*P. Deflersii* Pat., l.c.

*P. squamosus* Pat., *Bull. Soc. Myc. Fr.*, 7 (1891) 210.

*P. mexicanum* Ellis, *Journ. Myc.* 7 (1893) 274.

*P. Perraldieri* Pat., *Cat. Pl. Cell. Tunisae* (1897) 68.

*P. Glaziovii* P. Henn., *Hedwigia* 36 (1897) 210.

*P. ghattasensis* P. Henn., *Ibid.* 37 (1898) 287.

*P. Gollanii* P. Henn., *Ibid.*, 40 (1901) 338.

*P. algericus* Pat., *Bull. Soc. Myc. Fr.* 20 (1904) 53.

*P. Muelleri* P. Henn., *Hedwigia* 43 (1904) 187.

*P. macrosporus* Speg., *Anal. Mus. nac. Buenos Aires* 16 (1906) 27.

*P. termithophilus* Jun. et Perr., *Compt. Rend.* 145 (1907) 274.

*P. anomalam* Lloyd., *Myc. Writ.* 6, *Myc. Notes* 64 (1920) 992.

*Podaxis carcinomalis* (Linn. ex Pers.) Dodge, *Compt. Morph. Fungi* (1928) 495.

Plants up to 32 cm. tall, hypogenous at first, later developing above ground. *Peridium* usually long in proportion to the stipe, 2-15 cm. long, 1.3-8.5 cm. diam., long cone-shaped or oblong oval, with or without a blunt apex. *Exoperidium* smooth or covered with pendant, scattered or imbricate scales, which usually fall off. *Endoperidium* whitish-grey when young, later pale grey ochraceous, pale greyish brown, ochraceous brown or umber, more or less smooth, firm, compact, brittle, up to 4 mm. thick; typical dehiscence by the separation of the lower edge from the stem, followed by longitudinal splitting of the liberated margin; less frequently the whole endoperidium falls off, exposing the columella with closely attached mass of greenish brown gleba. *Stipe* 3-13 cm. long, 2-4 cm. thick, longitudinally striate to sulcate, often with pendant, imbricate scales caused by horizontal splitting due to rapid growth; stipe straight or bent, prolonged to the apex of the peridium as a columella, enlarged at the base to form a bulbous or tuberous structure composed of hyphae mixed with soil. *Gleba* copious, compact, finally olivaceous, reddish brown or almost black. *Capillitium* threads tinted to olivaceous or olivaceous-brown, varying in thickness, 3.4-19  $\mu$ , thin- or thick-walled, walls sometimes with spiral thickenings, straight, wavy or loosely spiral, sparingly branched, very sparsely septate. *Spores* 5-17  $\times$  4-11.9  $\mu$ , olivaceous brown to dark reddish brown, usually broadly oval, occasionally subglobose, sub-kidney-shaped, pyriform or irregular, often truncated, obscurely asperulate, sessile or attached by very short pedicels to basidia arranged in semi-persistent fascicles.

*Habitat*: most commonly on termite heaps, also in sandy or clayey soils; solitary or in groups.

*Distribution*: North, Central and South Africa; North and South America; Australia; India.

*Specimens examined*: on termite heaps, Pretoria, Feb. 1911, *I. B. Pole Evans*, 1186; Jan. 1929, *V. A. Wager*, 23672; Nov. 1933, *H. Schweickerdt*, 27280; Pretoria-Johannesburg road, *L. J. Kresfelder*, 26602; Garstfontein, Pretoria, April 1911, *P. J. Pienaar*, 1689; Feb. 1912, *I. B. Pole Evans*, 2120; Skinner's Court, Pretoria, Feb. 1912, *I. B. Pole Evans*, 2119; Hennops River, Pretoria, April 1912, *I. B. Pole Evans*, 5125, 20660; Impati Hills, Dundee, Natal, Dec. 1913, *E. M. Dodge*, 7362; Eshowe, Zululand, Feb. 1930, *C. J. Howlett*, 25361; Estcourt, Natal, April 1938, *O. West* 29955; *K. A. Lansdell*, 30714; Potchefstroom, July 1943, *J. Sellschop*, 34405; Kimberley, C.P., Feb. 1934, *Mrs. Broom*, 27369; July 1923, *N. Radloff* (v. d. *Byl* 1183); Hopetown-De Aar road, C.P., March 1933, *H. Schweickerdt*, 26690; Bloemfontein, 1878, *Exton* (P. MacOwan 1362; S.A.M. 34317) 22070; Knapdaar, C.P., March 1921, *Gideon Joubert*, 14507, April 1924, 18109; 25 miles north of Dordrecht on road to Aliwal North, Jan. 1946, *R. A. Dyer* 4736, 35425; Welgevonden, Tvl., Dec. 1934, *A. O. D. Mogg*, 28254; between Koelenhof and Mulders Vlei, C.P., April 1935, *J. Acocks* (E. L. Stephens 414); Somerset West Flats, April 1940, *S. Garside* (E. L. Stephens 507); Orange Free State, *P. v. d. Byl* 2802; Greenside Mission, Bizana Distr. Pondoland, April 1935, *E. Schaefer*, 28260; locality unknown (E. L. Stephens 399); ex Herb. Marlothiana, 26591 as *Phellorina Delastrei*; on hard red ground, between Windserton and Klipdam, Barkly West, C.P., June 1936, *J. P. H. Acocks* 406, 28641; on sandy soil, Sand River Drift, Messina, Nov. 1916, *I. B. Pole Evans*, 9789; on ground, Hammanskraal, Tvl., Feb. 1921, *M. R. H. Thompson*, 14484; Brits, March 1931, *J. W. Pont*, 25915; on (?) Pietersburg, Nov. 1912, *Rev. N. Roberts*, 5182; Kroonstad, Dec. 1912,

*P. v. d. Byl*, 5585; Klapmuts, C.P., 1934, *J. P. H. Acocks* (E. L. Stephens 400); Postmasburg, *E. Esterhuysen*, April 1940 (E. L. Stephens 509); South-West Africa, *Hilmar Luckhoff* (E. L. Stephens 399).

Specimens not seen: Ganekraal, *Thunberg*; without locality, *Burchell*; Uitenhage, *Zeyher* 99, Kew, Inanda, *Medley Wood* 405, Kew; "between Omtendo and Omsamculo" *Drège* 9454 a & c, 4115, Kew, *Drège* 9454 d, Paris; Stellenbosch, *Krige* (Duthie 283 a); Karroo, *Duthie* 24; Boroma, *Menghardt*; Olukonda, Amboland, *Schinz*; between Lopollo and Monimo, Huilla, *Welwitsch* 148; on banks of river Maiomba, Mossamedes, *Welwitsch* 149; southern Great Namaland, *Schultze*.

The distinguishing features of this species are the percurrent, columella-like stem, the typical basal dehiscence of the peridium by separation from the stem, the fasciculate basidia and the double-walled spores.

*Podaxis pistillaris* is the plant commonly known in South Africa as *Podaxon carcinomalis*. It is widespread in distribution but sporadic in appearance, occurring chiefly on termite heaps singly or less often in groups. Single specimens often resemble a snake's head at a distance. Plants growing on termite heaps are usually of a much larger type than those occurring on the ground, so much so, that the latter have often been considered as a separate species. The plant is very variable, not only in size but in external appearance, size and shape of spore and in capillitium characters.

## NIDULARIALES.

Growing on ground, wood, dead vegetable matter such as old sacks, coir matting, etc., and on dung.

Peridium sessile, small, cup-shaped, campanulate, goblet-shaped or subglobose, the mouth in two genera covered over until maturity by a membranaceous structure—the epiphram; dehiscing either in an irregular manner by the breaking of the wall or by the rupture of the epiphram. Peridioles one to many, globose or lenticular, usually black, with or without a thin, veil-like, superficial tissue, the tunica, embedded in mucilage in the peridium or attached to its inner wall by means of elastic threads—the funiculi. Basidia bearing 4-8 sessile or shortly sterigmate spores. Spores smooth, hyaline, globose or broadly oval. Capillitium absent.

There are only two families in this order—*NIDULARIACEAE* and *SPHAEROBOLACEAE*, both of which are represented in South Africa.

## NIDULARIACEAE Fries.

Systema Mycologicum 2 (1822) 296.

Peridium small, cup-shaped, campanulate or subglobose, 1-3 layered, enclosing a number of peridioles and dehiscing by the rupture of an apical membranaceous epiphram, or breaking up irregularly. Peridioles lenticular, smooth, attached to the inner wall of the peridium at different levels by white, cord-like, elastic funiculi or embedded in mucilage; consisting of a horny, dark-coloured wall enclosing the basidia and spores. Basidia clavate, bearing 4-8, usually 4, smooth, sessile or stipitate, apical or scattered spores. Spores smooth, hyaline, broadly oval, globose or subglobose.

The members of this family are popularly known as "Birds'-Nest fungi" owing to the resemblance of the peridioles to eggs in a nest. Of the four genera belonging to the family, only two—*Crucibulum* and *Cyathus* are represented in South Africa.

## Key to the Genera.

Peridioles attached to the cups by funiculi.

Peridium cup-shaped, with an epiphram.

Wall of peridium without a middle pseudoparenchymatous layer. Peridioles covered by a thick, white, tunica. Spores not mixed with threads 1. *Crucibulum*.

Wall of peridium with a middle pseudoparenchymatous layer. Tunica thin or absent. Spores mixed with threads..... 2. *Cyathus*.

Peridioles without funiculi.

Peridium cup-shaped, with an epiphram.....

(*Nidula*.)

Peridium subglobose, without a typical epiphram.....

(*Nidularia*.)

## 1. CRUCIBULUM Tulasne.

Annales des Sciences Naturelles, Sér. 3, I (1844) 89.

Type species: *Crucibulum vulgare* Tul.

Peridium cup-shaped or bell-shaped, sessile; wall composed of a single thick layer, which is originally densely tomentose on the outside, becoming almost smooth with age

Inside of cup smooth, without striae and covered with a thin, silvery lining. Apex covered by a thin, floccose epiphram, which soon disappears. Peridioles numerous, filling the cup, attached to the wall by means of simple, inconspicuous funiculi; covered with a thick, whitish, conspicuous tunica; the wall consisting of three layers, an outer thin layer of dark, interwoven filamentous cells, a middle one of dark, branched hyphae and an inner layer of hyaline hyphae.

This genus is represented by one species only, which is world-wide in distribution. It is recognised by the single peridium, the presence of an epiphram and the attachment of the peridioles to the inner wall by means of funiculi.

**Crucibulum vulgare** Tulasne, [Plate LXXVII, fig. 1.]

*Annales des Sciences Naturelles*, 3 Sér. I (1844) 90.

Sacc. *Syll. Fung.* 7 (1888) 43; Lloyd, *Myc. Writ.* 2, *Nidulariaceae* (1906) 13  
Verwoerd, *Ann. Univ. Stell.* 3 (1925) 38; G. H. Cunningham, *Gastero.* (1944) 203.

*Cyathus crucibulum* Pers., *Syn. Meth. Fung.* (1801) 238.

*Nidularia crucibulum* (Pers.) Fr., *Syst. Myc.* 2 (1822) 299.

*N. juglandicola* Schw., *Trans. Am. Phil. Soc.* 4 (1834) 253.

*Cyathus fimicola* Berk., *Journ. Linn. Soc.* 18 (1881) 387.

*C. pezizoides* Berk. l.c.

*C. pusio* Berk. l.c.

*Crucibulum juglandicolum* (Schw.) de Toni in Sacc. *Syll. Fung.* 7 (1888) 44.

*C. simile* Mass., *Grev.* 19 (1891) 94.

*C. crucibuliforme* (Scop.) White, *Bull. Torrey Bot. Club* 20 (1902) 269.

*C. levis* (DC.) Kambly, *Univ. Iowa Studies* 17 (1936) 167.

*Peridium* 3-6 mm. high, 3-8 mm. wide at apex, cupulate, slightly attenuated towards the sessile broad base, attached to the substratum by means of a light brown to tawny felt-like pad, straight or slightly flared. *Outer surface* tawny ochraceous, densely tomentose, becoming greyish brown and almost smooth with age. *Inner surface* dingy brown or whitish with a silvery lining which often finally disappears; margin even, thick; epiphram a thin, loosely woven tissue of two layers, the outer thin, floccose and of the same colour as the outer surface, the inner very thin, fragile, veil-like, both soon disappearing. *Peridioles* 2-2.8 mm., numerous (16 counted) filling the cup, the outlines often visible through the epiphram; attached to the wall by means of very thin, inconspicuous funiculi, consisting of fascicles of long, thin, occasionally branched hyphae with thickened joints; embedded in mucilage; smooth, round lenticular, slightly depressed at the umbilici from which the funiculi arise, black but appearing greyish white or pale brownish due to the presence of a thickish tunica. *Spores* oval, hyaline, smooth, 7.5-10  $\times$  4-5  $\mu$  diam.

*Habitat* : on decaying wood, twigs and other vegetable matter, gregarious.

*Distribution* : Cosmopolitan.

*Specimens examined* : Papegaaisberg, Stellenbosch, July 1925, *J. de Vos*, 31495; *Miss Loseby* (v. d. Byl 2671).

*Specimens not seen* : Stellenbosch, *L. Verwoerd* (Stell. 352).

## 2. CYATHUS Haller ex Persoon.

Synopsis Methodica Fungorum (1801) 236.

v. Haller, Historia stirpium Helvetiae 3 (1768) 127.

*Fungoides* Vaillant, Bot. Paris, Leidae et Amsterdam (1727) 57.

*Cyathoides* Micheli, Nova plantarum genera (1729) 222.

*Cyathia* P. Browne, Civ. & Nat. Hist. Jamaica (1756) 78; White in Bull. Torrey Bot. Club 29 (1902) 255.

Type species: *Cyathus olla* Pers.

Peridium sessile or substipitate, obovate or fusoid, becoming goblet-shaped or inverted bell-shaped, mouth at first closed by a whitish, grey or yellowish, membranaceous epiphragm, which ruptures and disappears at maturity; wall composed of three layers—a central pseudoparenchymatous layer between two layers of loosely woven filaments. Peridioles lenticular, compressed, umbilicate, 10–18 in number, attached to the wall of the cup by a conspicuous, white, complex, cord-like funiculus, black or dark brown, but colour often partly obscured by the presence of a thin, whitish tunica. Spores hyaline, smooth, elliptical or subglobose. Coker and Couch (Gastero. 1928) describe the internal structure of the peridioles as follows: "Basidia not forming a distinct or homogeneous hymenium, but scattered at irregular heights throughout a large central area and intermingled with numerous delicate threads which at maturity have their cell walls greatly thickened and gelatinised to form a solid, horny matrix, throughout which the spores are unevenly scattered. At the time the spores are growing, this matrix is not horny but gelatinous, becoming horny at maturity . . . The hyaline, sclerotic layer, composing the greater part of the wall, is composed of crumpled and distorted cell units with very thick walls. In *Cyathus* these units do not separate when crushed but break up into irregular masses and bits of cells; in *Crucibulum* they separate in great part when crushed." Basidia 2–4 spored. Spores smooth, hyaline, broadly elliptical, obovate or subglobose, intermixed at maturity with thick, horny filaments.

*Habitat*: Usually gregarious, on wood, soil, decayed vegetable matter and dung.

*Distribution*: cosmopolitan.

The genus *Cyathus* is recognised by the three-layered peridial wall, the well-defined epiphragm and the complex, cord-like funiculi.

## Key to the South African Species.

Inner surface of peridial cup without grooves or striae.

Spores less than 15  $\mu$  long.

Peridioles 1–1.5 mm. diam.

Spores up to 10  $\mu$  long . . . . .

Spores up to 4  $\mu$  long . . . . .

Peridioles 1.5–2 mm. diam.

Spores usually broadly elliptic; cups tapering towards base . . . . .

Spores usually more or less globose; cups abruptly narrowed towards base . . . . .

Peridioles 2–2.5 mm. diam., margin of cup usually straight . . . . .

Peridioles 2–3.5 mm. diam., margin of cup usually flared . . . . .

Spores 15–30  $\mu$  long, sub-globose . . . . .

Inner surface of peridial cup striate or sulcate.

Spores large, 15–44  $\mu$  long . . . . .

Spores medium, 10–20  $\mu$  long, egg-shaped . . . . .

Spores small, 7–10  $\mu$  long, sub-globose . . . . .

1. *C. dasypus*.

2. *C. minutosporus*.

3. *C. pallidus*.

4. *C. microsporus*.

5. *C. Hookeri*.

6. *C. olla*.

7. *C. stercoreus*

8. *C. Poeppigii*.

9. *C. Montagnei*.

10. *C. Berkeleyanus*

1. **Cyathus dasypus** Nees.

Horae physicae berolinensis (1820) t. 5, f. 1, p. 41.

Sacc. Syll. Fung. 7 (1888) 40; Verwoerd, S. Afric. Journ. Sci. 25 (1928) 238.

*Nidularia dasypus* Fries, Syst. Myc. 2 (1923) 299.

*Peridium* 5-10 mm. high, 5-7 mm. wide at the mouth, inverted cone-shaped; smooth and light coloured within, light brown and clothed with downy hairs outside. *Peridioles* 1-1.5 mm. diam., more or less round and lenticular, covered by a thin, light-coloured tunica. *Spores* more or less globose or egg-shaped, hyaline, smooth,  $10 \times 8-10 \mu$ . (Translated from Verwoerd l.c.)

*Habitat*: on manure and swampy and other ground.

*Distribution*: South Africa; Guadaloupe; Chile.

*South African records*: on ground, Caledon, C.P., Verwoerd 184; without locality, Pole Evans, det. Lloyd as "probably *C. dasypus*"; on swampy ground and manure, "Cape of Good Hope" as *Nidularia dasypus* Fr.

Lloyd originally thought that this species was a variety of *C. olla (vernicosus)* with irregular peridioles, but after examination of Verwoerd's collection, decided that it agreed with *Cyathus dasypus* in the original sense of Nees. It is recognised by its irregular, cinereous peridioles and the lead-coloured inner wall of the cup. The peridioles in *C. olla* are typically dark and 2-3.5 mm. in diameter.

2. **Cyathus minutosporus** Lloyd emend. Verwoerd.

Lloyd, Mycological Writings 7 (1924) 1325; Verwoerd, South African Journal of Science 25 (1928) 238.

*Peridium* 4-7 mm. high, 4 mm. wide at mouth, globose, sessile; outer surface moderately hairy, brown; inner surface smooth, brown. *Peridioles* 1-1.5 mm. diam., more or less spherical or lenticular, dark leaden coloured to black, with a relatively thin tunica. *Spores* usually small, egg-shaped, hyaline, smooth,  $4 \times 2 \mu$ . (Translated from Verwoerd l.c.)

*Habitat*: on clayey soil.

*Distribution*: South Africa.

*South African record*: Heidelberg, Transvaal, E. Neethling (Verwoerd 330; Lloyd Myc. Coll. 24889 Type).

The small size of the spores is the distinguishing feature of this species. The material from which the above description was made is said to have been weathered and it was thus impossible definitely to establish the characters and colour of the peridium.

3. **Cyathus pallidus** Berk. et Curt., [Plate LXXVIII, 3rd row.]

Cuban Fungi 517 in Journ. Linnean Society, London, Part II, 10 (1869) 341.

Verwoerd, Ann. Univ. Stell. 3 (1925) 7; Lloyd, Nidulariaceae in Myc. Writ. 2 (1906) 22; Sacc. Syll. Fung. 7 (1888) 37.

*Peridium* 6-9 mm. high, 4-7 mm. wide at mouth, goblet-shaped, tapering towards a substipitate base which arises from an ochraceous, felt-like pad (very conspicuous when the substratum is wood) typically straight, occasionally slightly flared. *Outer surface* clothed with ochraceous, light brown or dove grey, erect to spreading, strigose, matted hairs, which originally cover the incurved, depressed apex and finally often project slightly

beyond the margin in a fimbriate manner. The strigose hairs may partially disappear from the upper part of the mature cup. Colour of old cup grey or brown. *Inner surface* smooth, or sometimes slightly sulcate in old specimens, silvery grey or leaden, becoming dark grey. *Peridioles* 1.5–2 mm. diam., occasionally up to 2.5 mm., at first covered with a thin, silvery tunica, which later usually disappears, exposing the blackish peridioles; attached by strong, white funiculi to the wall of the cup. *Spores* usually 6.2–10.8 × 5.4–7.2  $\mu$ , sometimes larger, broadly elliptical, sometimes subglobose or obovate.

*Habitat* : gregarious, on dead wood, dung, soil and decayed vegetable matter.

*Distribution* : South Africa; Antigua; Cuba; Jamaica.

*Specimens examined* : on dead wood, Pretoria, *D. J. Fouche*, Jan., 1922, 15649; *A. Hean*, Feb. 1939, 30727; *H. V. King*, March 1937, 28806; Fountains, Pretoria, March 1939, *A. Hean*, 30692; *B. Louwrens*, 28619; Fairy Glen Road, Pretoria, *E. M. Doidge*, 30690; Garstfontein, Pretoria, *A. Hean*, 30689; Kromrivier nr. Buffelspoort, Marikana, Tvl., *E. M. Doidge & A. M. Bottomley*, 33254; Lemana, Spelonken, N. Tvl., Aug. 1911, *E. M. Doidge*, 1699; Grahamstown, *E. L. Stephens* 255, 27275; Kingwilliamstown, Sister de Victoria, July 1930, 25486; Knysna, *A. V. Duthie* 114, 31357; Woodbourne, Knysna, *A. V. Duthie* 63, 31327; Deepwalls, Knysna, *A. M. Bottomley*, 30772; Pietermaritzburg, Natal, *Rump* 65, Aug. 1934, 27681; *I. B. Pole Evans*, April 1911, 1340, Kew; Mooi River, Natal, *Crass* (Rump 444) 28605; Xumeni Forest, Natal, Jan. 1935, *E. M. Doidge*, 27735; Hopevale, Donnybrook, Natal, Dec. 1940, *E. M. Doidge*, 33174; on soil, decayed vegetable matter or dung, Rietondale, Pretoria, Feb. 1936, *L. J. Kresfelder*, 28865; Mamagalieskraal, Brits, Tvl., *D. J. Fouche*, Jan. 1927, 21084; Hopevale, Donnybrook, Natal, Dec. 1949, *E. M. Doidge*, 33257; Kaapmuiden, E. Tvl., April 1914, *H. A. Wager*, 7727; Johannesburg, Jan. 1930, *Dr. A. Porter* (v. d. Byl 2550); Garstfontein, Pretoria, *E. M. Doidge*, 1348, 30728; *E. M. Doidge & A. Hean*, Feb. 1943, 30693; Fort, Grahamstown, *N. J. G. Smith* (E. L. Stephens 492, N. J. G. Smith 20).

*Specimens not seen* : Somerset East, C.P., *MacOwan*; Knysna, *Verwoerd* (Stell. 109); ? Grahamstown, *N. J. G. Smith*, Kew.

This species differs from *C. olla* in having strigose, matted hairs on the outer surface of the cup and usually smaller spores and peridioles.

#### 4. *Cyathus microsporus* Tulasne, [Plate LXXVII, 3rd row.]

Monograph Nidulariees, Ann. sc. nat., 3 séér., I (1844) 73, f. 6–8.

Sacc. Syll. Fung. 7 (1888) 35; Verwoerd, Ann. Univ. Stell. 3 (1925) 37.

*Peridium* 7.8 mm. high, 6–9 mm. wide at mouth, funnel-shaped, abruptly narrowed towards the shortly stipitate base, attached to the substratum by a pale brown mycelial pad; *outer surface* greyish-brown, striate, clothed with rough, brown, adpressed, interwoven hairs, becoming more or less smooth; *inner surface* even, not striate. *Peridioles* 1.5–2 mm. diam., more or less globose, grey, with a thin tunica. *Spores* elliptic or obovate, smooth, hyaline, 4.4 × 6.4  $\mu$ .

*Habitat* : dead wood.

*Distribution* : South Africa; Brazil; Haiti.

*Specimens examined* : Pietermaritzburg, Natal, Dec. 1915, 9205, det. Lloyd.

*Specimens not seen* : Knysna, *Duthie* 230, 31416; without locality, *Verwoerd* (Stell. 108); Stikland, *J. Acocks* (E. L. Stephens 465).

This species differs from *C. Berkeleyanus* in the smooth, not striate, inner surface of the cups.

The Pietermaritzburg specimen, No. 9205, was identified by Lloyd as *C. microsporus*, attention being called to the small size of the spores, which he found to measure  $6\text{--}7\ \mu$ . An examination of the duplicate material, however, showed spores of the sizes  $6\cdot8\ 11\ \times\ 5\text{--}6\cdot8\ \mu$ . Since a smaller spore is called for, I am not satisfied that the above specimen is *C. microsporus* and have tentatively referred it to *C. olla*. Our specimen of *Duthie 230*, also identified by Lloyd, has unfortunately only the basal mycelial pads left, so no comparison is possible. Verwoerd's measurements are quoted above.

5. **Cyathus Hookeri** Berkeley, [Plate LXXVII, 2nd row.]

in Hooker's Journal of Botany 6 (1854) 204.

Sacc. Syll. Fung. 7 (1888) 35; Lloyd, Myc. Writ. 2, Nidulariaceae (1906) 28  
G. H. Cunningham, Gastero. (1944) 205.

*Peridium* 9–10 mm. high, 5–8 mm. wide at mouth, common size  $10 \times 7$  mm., long goblet-shaped, gradually attenuated towards a very thin base, attached by means of a pale brown, cushion-like pad; margin straight or slightly flared, even, finely crenulate or finely fimbriate; *outer surface* ochraceous-brown to greyish-brown, clothed with matted strigose hairs which partially disappear with age; *inner surface* smooth or sometimes obscurely sulcate, putty coloured, grey or pale brown. *Peridioles* 2–2.5 mm. diam., broadly oval, lenticular, wrinkled, black, but colour obscured by the thin, whitish tunica, which makes them appear leaden. *Spores* typically broadly oval, also subglobose and obovate, smooth, tinted yellowish, thick-walled,  $6\cdot8\text{--}11 \times 7\text{--}8\ \mu$ .

*Habitat*: on dead wood.

*Distribution*: India; New Zealand; South Africa.

*Specimens examined*: Pretoria, Jan. 1919, *I. B. Pole Evans*, 12311, det. Lloyd; Hogsback, Alice, C.P., Dec. 1937, *K. Putterill*, 30814.

The South African plant identified by Lloyd as *C. Hookeri* is very near *C. pallidus*, from which it appears to differ only in the more slender shape, the thinner base and possibly slightly wider spores. The New Zealand plant, however, also determined by Lloyd, is near to *C. olla* (Cunningham, *l.c.*) being finely tomentose and bay brown in colour. Our plant seems more nearly to conform to the original description of *C. Hookeri* in having matted, strigose hairs and being pale in colour. In Lloyd's remarks about Pole Evans' collection he says "the spores are small,  $6\cdot8\ \mu$  and the species like *C. microsporus* except for the pale (not dark) cups". In the Putterill collection, the spores are rather larger,  $7\text{--}11 \times 7\text{--}8\ \mu$ .

The South African plant further differs from the New Zealand plant as regards the middle layer of the peridial wall, which is pseudoparenchymatous and not formed of deeply coloured, woven hyphae, as described by Cunningham.

6. **Cyathus olla** Persoon, [Plate LXXVIII, fig. 1.]

Synopsis methodica fungorum (1801) 237.

G. H. Cunningham, Gastero. (1944) 206.

*Cyathus vernicosus* (Bull.) DC., Fl. Fr. 2 (1805) 270; Sacc. Syll. Fung. 7 (1888) 38; Verwoerd, Ann. Univ. Stell. 3 (1925) 37; Fischer, Nat. Pflanzenfam. 2 Aufl., 7 a (1933) 59.

*Nidularia vernicosa* Bull., Hist. Champ. Fr. 1 (1809) 164.

*N. plumbea* Pers., Champ. Comest. (1818) 110.

*N. fascicularia* Schw., Trans. Am. Phil. Soc. 4 (1834) 253.

*Cyathus campanulatus* Corda, Anleit. 80 (1842) 19.

*C. similis* Cooke, Grev. 8 (1879) 58.

*Cyathus lentifera* (L.) White, Bull. Torrey Bot. Club 29 (1902) 264.

*Nidularia olla* Link, Obs. I, Mag. Ges. nat. Freunde III (1809) 34.

*Peridium* 5-15 mm. high, 5-13 mm. wide at mouth, goblet- or bell-shaped, tapering to the sessile or substipitate base; mouth incurved when young, becoming typically flared, but often straight in mature specimens of the same collection, sometimes obscurely striate in old specimens; *outer surface* light brown or straw-coloured, usually becoming greyish brown, covered at first with woolly, tomentose, adpressed hairs, finally sometimes almost smooth or with scattered greyish brown hairs; *inner surface* even, smooth, leaden, greyish brown or silvery brown. *Peridioles* 2-3.5 mm. diam., usually large but very variable in size even in the same cup, lenticular, dull olive brown to blackish when old, originally pale grey when covered with a thin, whitish tunica which disappears with age; attached by strong, white, easily detachable funiculi. *Spores* 6.8-13.6  $\times$  5.7  $\mu$ , broadly elliptical, obovate.

*Habitat*: on dead wood, soil or decayed vegetable matter, during rainy season; gregarious.

*Distribution*: North and South Africa; North and South America; Australia; New Zealand.

*Specimens examined*: Fountains Valley, Pretoria, March 1918, *H. Melle*, 11328, det. Lloyd; *A. M. Bottomley*, March 1924, 18141; Wonderboom, Pretoria, March 1929, *L. Reinecke*, 23705; Pelindaba nr. Pretoria, *P. Watson*, Feb. 1930, 25157; Wellington, C.P., *A. M. Bottomley*, May 1911, 1696; Stellenbosch, *A. V. Duthie* 280, 31453, 171, 31380, 252, 31433; Knysna, *J. Phillips*, Feb. 1925, 20608; Mamathes, Basutoland, *A. Hean*, Feb. 1941, 33494; Fauresmith, O.F.S., *Botha*, May 1934, 27573; Port Elizabeth, *Director of Museum*, July 1939, 30782; Bloemfontein, *G. Potts* 7190, March 1917, 13010; Hopevale, Donnybrook, Natal, Jan. 1935, *E. M. Dodge*, 28923; Pietermaritzburg, Natal, *J. M. Sim*, Dec. 1915, 9205 det. Lloyd as *C. microsporus*; Stellenbosch, *Champion* (v. d. Byl 2044 as *C. vernicosus*); Hopefield, C.P., Oct. 1923, v. d. Byl 1265 as *C. vernicosus*; Lady Grey, C.P., Feb. 1925, *R. I. Nel* (v. d. Byl 2349) as *C. vernicosus*; without locality, ex Herb. Lloyd, v. d. Byl 1419 as *C. vernicosus*; Somerset East, 1874, *MacOwan* 1042, 20981; 1875, *MacOwan* 1042 as *Nidularia farcta* Fr. (S.A.M. 35075), 20837; Fischhoek, C.P., 1934, *V. Peers* (E. L. Stephens 397).

*Specimens not seen*: Bloemfontein, Verwoerd as *C. vernicosus*; Sea Point, Cape Town, *Duthie* 31.

The characteristic features of this species are the straw-coloured, woolly outer surface of the immature plant and the large peridioles. The spores are usually larger than those of *C. pallidus* but vary considerably in size.

#### 7. *Cyathus stercoreus* (Schweinitz) de Toni. [Plate LXXVIII, 2nd row.]

in Saccardo's Sylloge Fungorum 7 (1888) 40.

Lloyd, Myc. Writ. 2, Nidulariaceae (1906) 19; Verwoerd, Ann. Univ. Stell. 3 (1925) 37; G. H. Cunningham, Gastero. (1944) 206.

*Nidularia stercorea* Schw., Trans. Am. Phil. Soc. 4 (1834) 253.

*Cyathus Wrightii* Berk., Grev. 2 (1873) 34.

*C. Baileyi* Mass., Grev. 21 (1892) 3.

*C. dimorphus* Cobb, Agric. Gaz. N.S.W. (1892) 1005.

*C. affinis* Pat., Bull. Soc. Myc. Fr. (1895) 87.

*C. rufipes* Ell. & Ev., Bull. Torrey Bot. Club 24 (1897) 125.

*C. rufipes* (Ell. & Ev.) White, l.c. 29 (1902) 265.

*C. Wrightii* (Berk.) White, l.c.

*C. stercoria* (Schw.) White, l.c., 266.

*Peridium* 3.5-8 mm. high, 3.5-6 mm. wide at mouth, urceolate or goblet-shaped, tapering towards the sessile or sub-stipitate base, which sometimes arises from a light brown, felt-like mycelial pad, especially when on wood; solitary or gregarious, often occurring in dense clusters resembling a wasp's nest; usually becoming crumpled when old; *outer surface* grey, greyish brown or ochraceous, at first hairy or almost tomentose with a light brown, felt-like covering over the depressed apex, becoming more or less smooth or sparsely strigose with age; *inner surface* smooth, leaden, then dark greyish brown or almost black; mouth smooth or fimbriate, sometimes slightly sulcate in old specimens. *Peridioles* 1.5-2.5 mm., lenticular, smooth, black with metallic sheen, without a tunica; outer wall thick, composed of coarse brown fibrils; usually attached by a funiculus, but this appears to be lacking in some cases. *Spores*, many or few, typically large, 13.6-37.4  $\times$  10.2-30.6  $\mu$ , very variable in size even in one peridiole; globose, subglobose, broadly elliptical, egg-shaped, smooth, thick-walled and granular when mature.

*Habitat*: usually gregarious; on dung, soil, rotten wood and other decaying vegetable matter.

*Distribution*: World-wide.

*Specimens examined*: on decaying wood, Pretoria, Feb. 1915, Bischoff 8817; Glen, O.F.S., April 1921, Potgieter, 14690; Fort Hare, Aliceade, Giffen, Aug. 1934, 27502; Pretoria, Jan., M. Bosman, 23668; Knysna, Duthie 311b (E. L. Stephens 65); on manure, Potchefstroom, June 1927, H. A. Lawrence, 21929; Hopevale, Donnybrook, Natal, Jan. 1935, E. M. Doidge, 3317, 27718; K. E. Morgan, Feb. 1935, 28922; Fountains Valley, Pretoria, March 1936, B. Lourens, 28620; Komgha, C.P., April 1936, Cooke, 28589; on soil, Onderstepoort nr. Pretoria, March 1924, Dr. Curson, 18116; Bloemfontein, March 1917, H. G. Purkiss (Grey Univ. Coll. Herb. 7204) 13015; Pretoria, 1907, I. B. Pole Evans, 1902; Pietermaritzburg, J. M. Sim, Feb. 1915, 8823; Kimberley, March 1915, J. C. Moran, 8963; Pretoria, March 1924, C. Punt, 18142, Kresfelder, Jan. 1931, 25870; Johannesburg, Mrs. Moss, March 1935 (T.R.L. 283) 29941; without locality, ex Farmer's Weekly, March 1929, 25316; Haenertsburg, Tvl., March 1938, S. Thompson (T.R.L. 282); on rotting sack, Buffelspoort, Marikana, Tvl., F. A. S. Turner, 30687; Hopevale, Donnybrook, Natal, Jan. 1935, E. M. Doidge, 35144 (with *Sphaerobolus stellatus*); Pretoria, v. d. Byl 1428 det. Lloyd; Salisbury, S. Rhodesia, Eyles 4101 (v. d. Byl 2347, S. Rh. 161); Nardouw Pass, C.P., Aug. 1941, P. C. de Kock (E. L. Stephens 560).

*Specimens not seen*: Livingstone Is., Victoria Falls, S. Rhodesia, Cheesman; without locality, R. Marloth.

This species is characterised by its large, globose or subglobose spores, its black peridioles, often closely aggregated and crumpled appearance and the dark interior of the cups.

forma **Leseurii** Tulasne, [Plate LXXVIII; 2nd row.]

Ann. Sci. nat. 3 Sér., I (1844) 79.

Sacc. Syll. Fung. 7 (1888) 38; Lloyd, Myc. Writ. 2, Nidulariaceae (1906) 21, Plate 108, figs. 10-11; Coker & Couch, Gastero. (1928) 179.

*Peridium* long goblet-shaped, 10-12 mm. high, 6-7 mm. wide at the mouth, shortly stipitate, arising from a large, rufous-brown mycelial pad; *outer surface* light greyish brown,

clothed with coarse, matted, shaggy hairs, which may partially disappear in the upper part, margin even; *inner surface* smooth, silver grey, becoming dark greyish brown. *Peridioles* nearly black, resembling black lead, without a tunica, up to 2.5 mm. diam., with thick, rigid outer wall consisting of dark, reddish brown fibrils: attached or not attached by funiculi. *Spores* large, globose, subglobose, broadly elliptical, thick-walled and yellowish, granular when mature,  $23.8-34 \times 23.8-27.2 \mu$ .

*Habitat*: on manured ground and sandy soil, gregarious.

*Distribution*: North America; South Africa.

*Specimens examined*: on manured ground, Brits, Tvl., *J. v. d. Plank*, June 1942, 33503.

The above collection of seventeen individuals differs from typical *Cyathus stercoreus* mainly in shape and size of the cups. These are much longer in proportion to the width, more stipitate, lighter in colour both externally and especially internally, being greyish brown instead of nearly black inside, and do not become crumpled when old, as most of the typical plants do. The peridioles are larger and the spores more uniformly globose or subglobose. These specimens resemble Lloyd's photograph (l.c.) of material at Paris. They differ from Coker and Couch's description (l.c.) in the taller and less slender shape, the absence of hairs on the mouth and the larger size of the peridioles, but agree with their illustration (l.c. plate 123) in shape. The Australian typical plant (Cunn. l.c. plate 32) resembles the South African uncommon "forma *Leseurii*".

8. *Cyathus Poeppigii* Tulasne, [Plate LXXVIII, 4th row.]

Monograph Nidulariées in *Ann. Sc. nat.* 3 sér., I (1844) 70, t. 10, figs. 9-11.

Verwoerd, *Ann. Univ. Stell.* 3 (1925) 36; *Sacc. Syll. Fung.* 7 (1888) 37; Coker & Couch, *Gastero.* (1928) 177, plate 121.

*Cyathus plicatilus* Poepp., *Hautlubens*, exs. n. 47.

*C. sulcatus* Kalchbr., *Grevillea* 10 (1882) 107.

*Peridium* 5-10 mm. high, 4-7 mm. wide at mouth, goblet-shaped, often crumpled when old, arising from a mycelial pad, which is very conspicuous in young plants growing on wood; usually strongly sulcate, dark brown to blackish when old; *outer surface* clothed when young with dark brown, matted shaggy hairs, which later partially disappear, exposing the slightly or distinctly striate or sulcate surface; *inner surface* leaden or slate grey at first, becoming dark brown to blackish with age, shiny, striate-fluted in upper part. *Peridioles* lenticular, 1.25-2 mm. diam., black, dull at first owing to the presence of a thin, white, film-like tunica which gradually disappears, finally black-lead colour, smooth, attached by strong, white funiculi. Outer wall of peridioles thick, consisting of coarse brown fibrils. *Spores* few to many,  $15.3-44 \times 10.2-23.8 \mu$ , comparatively few longer than  $34 \mu$ ; size very variable even in the same peridiole, subglobose, broad-elliptic or egg-shaped, sometimes depressed along the sides (for illustration of spores cf. Coker & Couch, *Gastero.* N. Amer., Plate 121). Van der Byl found the spores to be  $36 \times 28 \mu$ .

*Habitat*: on soil or dead and rotting wood.

*Distribution*: East and South Africa; North and South America; Australia; Mauritius; West Indies.

*Specimens examined*: Pretoria, March 1921, *C. Punt*, 14500; de Beer's Rust, Pretoria, Feb. 1939, *A. Hean*, 30691; Port Durnford, Zululand, *S. S. Ballenden* (Natal Herb. 910), 32011; Inanda, Natal, *J. Medley Wood* 334 as *C. sulcatus* Kalchbr. 11186, 10454; Pietermaritzburg, *J. M. Sim*, Feb. 1915, 8803; Rump, Jan. 1933, 26846, *Rump* 544, 33962; Sibasa, Zoutpansberg, Feb. 1920, *Rev. Junod*, 12826; Durban, *v. d. Byl* 594, 597 det. L. Verwoerd as *C. plicatulus* in *G. C. Nel*, *Ann. Univ. Stell.* 20 (1942) 71.

9. **Cyathus Montagnei** Tulasne, [Plate LXXVII, 4th row, left.]

Monograph. Nidulariées in Annales des Sciences Naturelles, 3 Sér. I (1844) 70, t. 10, f. 9-11.  
 Sacc. Syll. Fung. 7 (1888) 34; Verwoerd, Ann. Univ. Stell. 3 (1925) 35.

*Peridium* 5-10 mm. high, 5-9 mm. wide at mouth, goblet-shaped, attached to wood by a conspicuous, ochraceous yellow mycelial cushion; *outer surface* clothed with matted, brown, strigose hairs, which partially disappear from the upper part; *inner surface* striate, lead-coloured, smooth and shining. *Peridiolae* 1-2 mm. diam., globose to elliptic, lenticular, leaden coloured, with a thin tunica. *Spores* broadly oval to egg-shaped, smooth, more or less hyaline,  $7.5-14.4 \times 5.2-7.2 \mu$  (sec. Saccardo  $20 \times 13.2 \mu$ ).

*Habitat*: on wood.

*Distribution*: South Africa; South America; Ceylon.

*Specimens examined*: on woody fruits, Knysna, *E. du Preez* (v. d. *Byl* 1330, det. Lloyd); Kirstenbosch, *M. Johns* (E. L. Stephens 554).

*Specimens not seen*: without locality, *Verwoerd* (Stell. 156).

Tulasne's original description has not been seen, but according to the information given in the footnote to the description in the *Sylloge Fungorum* (l.c.) this species resembles *C. striatus* structurally, but differs in the reddish and less hirsute outer surface and in the glabrous, only slightly striate, inner surface.

10. **Cyathus Berkeleyanus** Tulasne, [Plate LXXVII, 4th row, right.]

Monogr. Nidulariées in Ann. Sci. Nat., 3 sér., I (1884) 70.  
 Lloyd, Myc. Writings 2, Nidulariaceae (1906) 19; White, Nid. N. Am. in Bull. Torrey Bot. Club 29 (1902) 258; Verwoerd, Ann. Univ. Stell. 3 (1925) 36.

*Cyathus microsporus* var. *Berkeleyanus* Tul., Sacc. Syll. Fung. 7 (1888) 35.

*Peridium* 5-9 mm. high, 4-7 mm. wide at the mouth, urceolate, attenuated towards a rather broad base, attached to the substratum by a pale brown cushion-like pad; margin erect or somewhat flaring, finely fimbriate; *outer surface* clothed with matted, strigose, ochraceous-brown hairs, which originally extend over the depressed epiphragm, sometimes becoming sulcate when old; *inner surface* sulcate or not, greyish brown or slate-grey. *Peridiolae* 1.5-2.5 mm. diam., lenticular, dark leaden colour due to the presence of a thin tunica, which masks the black colour. *Spores* broadly oval, obovate or sometimes sub-globose, smooth, hyaline,  $6.5-10 \times 5-7.2 \mu$ .

*Habitat*: on dead wood, gregarious.

*Distribution*: South Africa; North America; Brazil; Cuba; Jamaica.

*Specimens examined*: Belvidere, Knysna, Juné 1921, *A. V. Duthie* 311 det. Lloyd (E. L. Stephens 65, mixed with *C. stercoreus*) 31478; Nottingham Road, Natal, v. d. *Byl* 556 (Lloyd Myc. Coll. 34544) 31815; v. d. *Byl* 60; Knysna, April 1939, *A. M. Bottomley*, 30744.

*Specimens not seen*: Belvidere, Knysna, *A. V. Duthie* (Lloyd Myc. Coll. 22529, 34552 34554).

A note attached to Dr. Duthie's specimen reads: "The striations are not evident on all cups. The small spores  $6.8 \times 10 \mu$  are the feature of the species." In specimen v. d. *Byl* 60, the striations are very indistinct both internally and externally. The striate character of the cup appears to be a variable feature, since both smooth and striate plants

are found in the same collection. Lloyd (l.c. plate 107) gives illustrations of cups which are strongly sulcate both inside and outside, while White (l.c.) illustrates cups which are striate only on the inner side.

### SPHAEROBOLACEAE Schroeter.

Kryptogamen-Flora von Schlesien 3 (1889) 688.

Walker, Develop. and Mechanism of Discharge in *Sphaerobolus iowensis* n. sp. and *S. stellatus* Tode, in Journ. Elisha Mitchell Sci. Soc., U.S.A. 42 (1927) 151; Buller, Res. on Fungi 5 (1933) 279.

Peridium subglobose, wall of four layers, containing a single peridiole, which is forcibly ejected to a distance of a few inches up to 18 feet in a horizontal direction and 14 feet in a vertical direction (Walker, l.c.) by the apical splitting of the peridium and the eversion of the two inner layers. The four layers from outside inwards consist of (1) a gelatinous layer, (2) a pseudoparenchymatous layer, (3) a fibrous layer and (4) a palisade layer. After ejection, layers (3) and (4) resemble a translucent, yellowish vesicle at the top of, and attached to the remaining outer layers of the wall. The peridiole contains, in addition to a mass of oval spores embedded in mucilage, large spherical cystidia, which form a peridial layer next to the outer wall and, scattered among the spores, a number of tear-shaped gemmae which germinate and function as spores.

This family is separated from the Nidulariaceae in having a four-layered peridial wall, a single peridiole with cystidia and gemmae in addition to spores and a complicated method of dehiscence.

The decision to include *Sphaerobolaceae* in the *Nidulariales* instead of in the *Sclerodermatales* as Fischer does, is based on the findings of Walker (l.c.) who established that although in *Sphaerobolus stellatus* true glebal chambers are never present, in *S. iowensis* true chambers are present which persist up to maturity, and the basidia are arranged in definite hymenia, the hymenium lining the cavity of the glebal chamber.

### SPHAEROBOLUS Tode ex Persoon.

Synopsis Methodica Fungorum (1801) 115.

Type: *Sphaerobolus stellatus* Tode ex Persoon.

Peridium subglobose, four-layered, dehiscing at the apex into stellate lobes when the two innermost layers of the wall evert and eject the single peridiole. Peridiole globose, containing a mass of smooth, hyaline, oval spores mixed with cystidia and gemmae.

According to Walker, there are only two species of *Sphaerobolus*—*S. stellatus* and *S. iowensis* Walker. Of these only the former has been found in South Africa.

#### *Sphaerobolus stellatus* Tode ex Persoon, [Plate LXXIX.]

Synopsis Methodica Fungorum (1801) 115.

Walker, Journ. Elisha Mitchell Sci. Soc., U.S.A., 42 (1927) 151.

Buller, Res. Fungi 5 (1933) 279; Sacc. Syll. Fung. 7 (1888) 46; G. H. Cunningham, Gastero. (1944) 208.

*S. stercorarius* Fr., Syst. Myc. 2 (1822) 310.

*S. tabulosus* Fr. l.c.

*Carpobolus stellatus* Desm., Mem. Soc. Linn. 4 (1826) 32.

*Peridium*. Unexpanded plant 1.5-2 mm. diam., subglobose, more or less submerged in the substratum (dung) impregnated and often covered with copious, white mycelial growth, finally splitting at the apex in stellate fashion into 6-8 acute lobes, when the plant is 2-3 mm. across the mouth. *Outer surface* straw-coloured, slightly tomentose-hairy; *inner surface* smooth, orange, fading to cream or ochraceous yellow. *Peridiole* about 1.5 mm. diam., reddish brown, finally black and shining, globose or flattened above, containing a mass of spores embedded in mucilage and mixed with a number of larger cystidia and oval or tear-shaped gemmae. *Spores* hyaline with dark episporule, usually broadly oval, sometimes subglobose,  $5.1-8.5 \times 4-5 \mu$ .

*Habitat* : usually gregarious, on twigs, sticks, decaying stumps, boards, sawdust, old sackings, dung of herbivorous animals, etc.

*Distribution* : South Africa; Australia; Canada; Ceylon; England; Europe; India; Japan; New Zealand; Trinidad; United States of America.

*Specimens examined* : on equine dung, Pretoria, Feb. 1915, *I. B. Pole Evans*, 8821; Ixopo, Natal, March 1917, *E. Hackland* (Natal Herb. 470) 15550; Hopevale, Donnybrook, Natal, Jan. 1935, *E. M. Doidge*, 27719; Fountains Valley, Pretoria, March 1936, *A. M. Bottomley* 28462; on cow dung, Kromrivier nr. Buffelspoort, Marikana, Tvl., Dec. 1938, *E. M. Doidge & A. M. Bottomley*, 30236; nr. Somerset East, *W. Tuck*, 1976 (MacOwan 1190; S.A.M. 35083).



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PLATE II.

Fig. 1.—*Secotium Gueinzii*, x 1.

FIG. 2.—*S. Gueinzii*, basal view, x 1.

Unless otherwise stated all photographs are the work of  
Mr. H. A. V. King, photographer to the Division of Botany and  
Plant Pathology, Pretoria.

## PLATE I.

Fig. 1.—*Rhizopogon luteolus*, x 1.  
Fig. 2.—*Rhizopogon rubescens*, x 1.  
Fig. 3.—*Hymenogaster albellus*, x 1.  
Fig. 4.—*Melanogaster ambiguus*, x 1.



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PLATE III.

Fig. 1.—Section through *Secotium Gueinzii*,  $\times 1$ .

Fig. 2-6.—*Secotium obtusum*,  $\times 1$ .

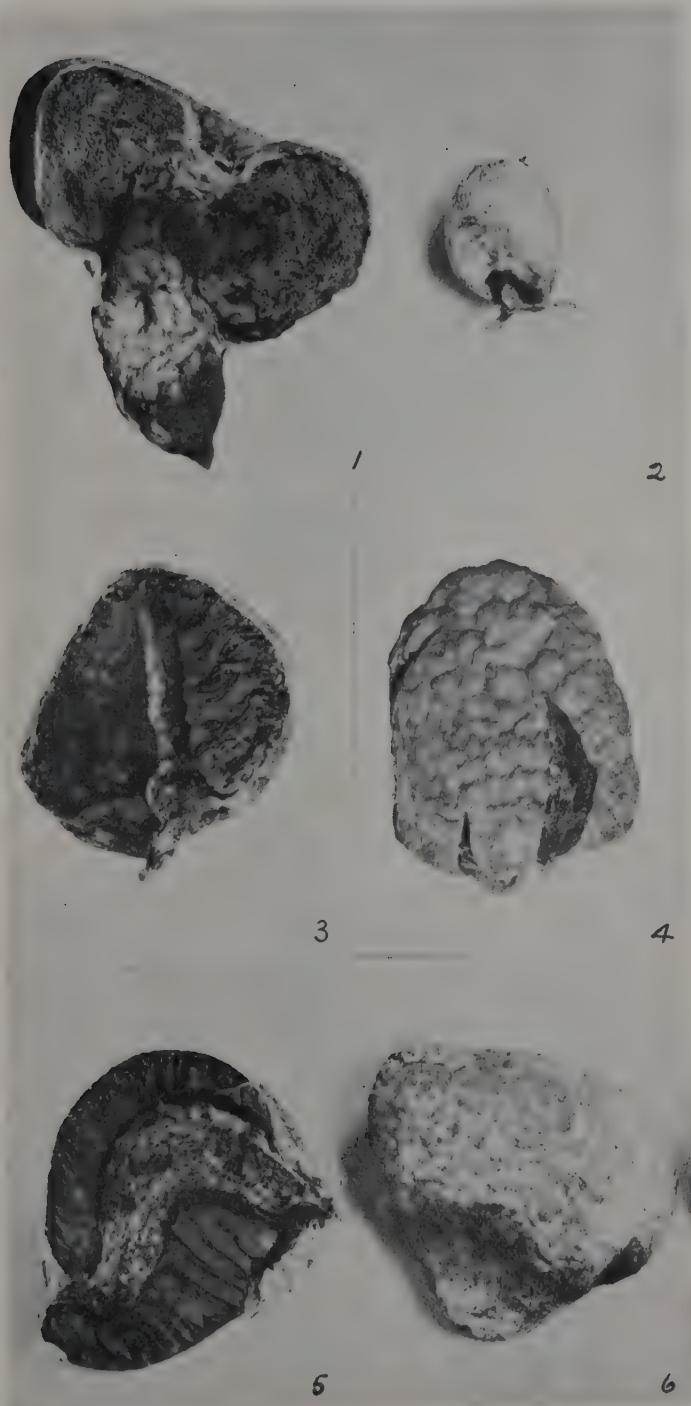


PLATE IV.

Fig. 1.—*Macowanites agaricinus* after Berkeley.

Fig. 2.—*Gyrophragmium Delelei*.—Microscopic section through  
trama plate.

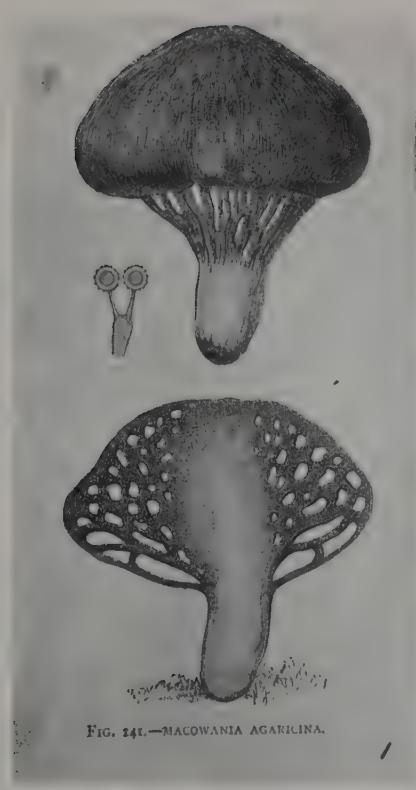


FIG. 241.—MACOWANIA AGARICINA.

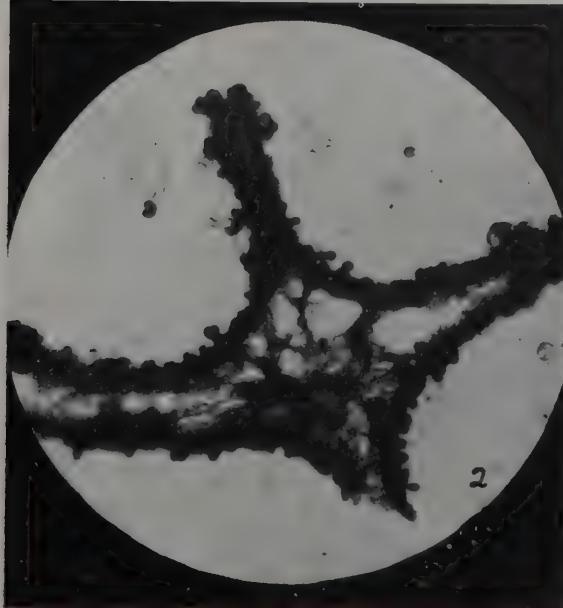


PLATE V.

Fig. 1.—*Polyplodium inquinans*, young plants growing from an heap.  
Reduced.

*Photograph by I. B. Pole Evans.*



PLATE VI.

Fig. 1.—*Polyplodium inquinans*, immature plant, reduced.

Fig. 2.—*P. inquinans*, section through (1).

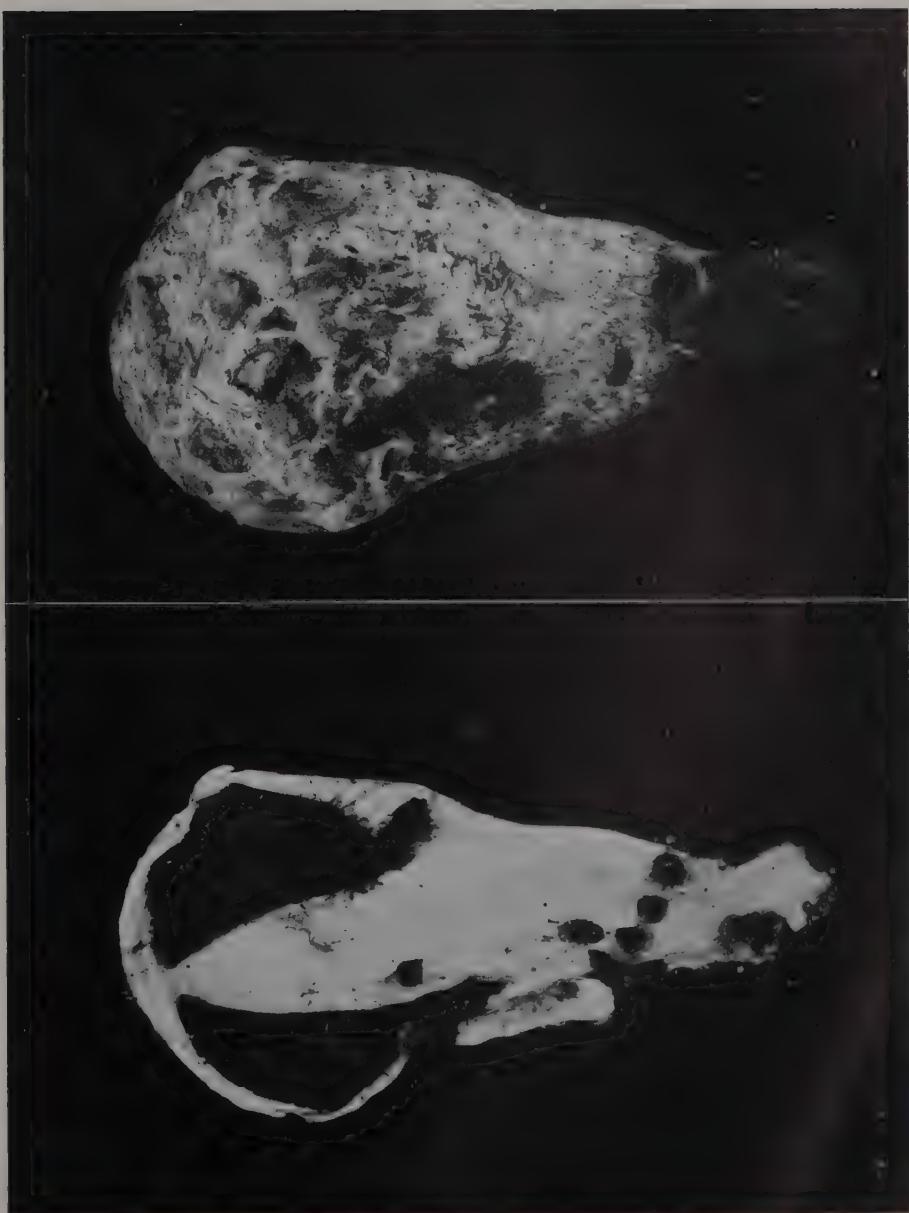


PLATE VII.

*Polyplocium inquinans*, mature plant, x 3.



PLATE VIII.

*Polyplocium inquinans*, mature plant showing warts on peridium  
and volva, x 1.



PLATE IX.

*Gyrophragmium Delilei*, mature plants, x 1.



PLATE X.

Fig. 1.—*Mutinus Curtissii*, after Lloyd as *M. elegans*, x 1.

Fig. 2.—*Mutinus bambusinus* after Lloyd, x 1.



PLATE XI.

*Itajahya galericulata*.—Stages in "egg" development, x 1.

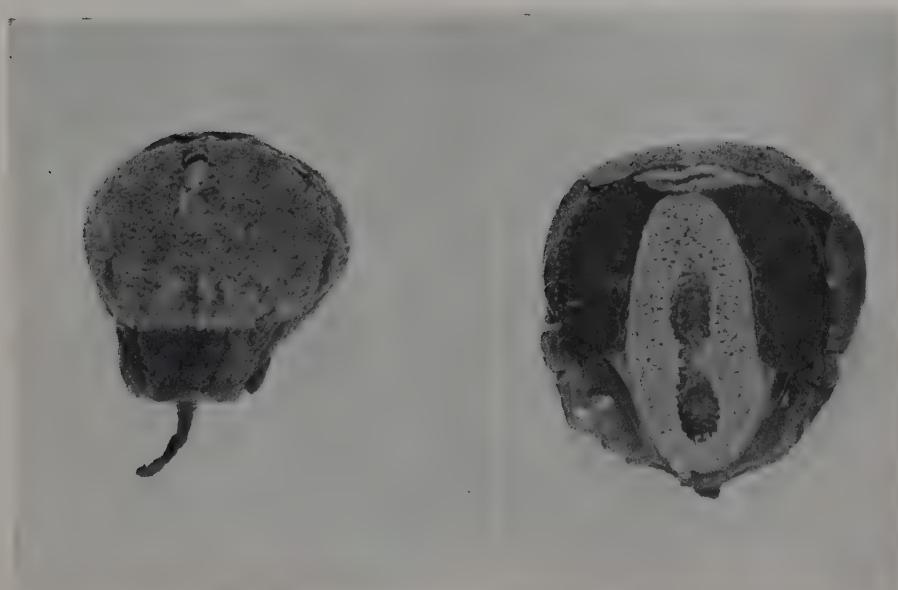
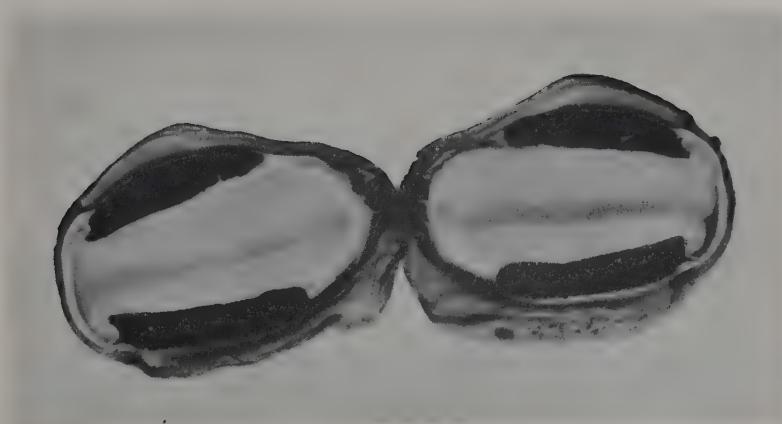


PLATE XII.

*Itajahya galericulata*.—Stage I in development of plant, x 1.



PLATE XIII.

*Itajahya galericulata*.—Stage II in development of plant. x 1.



PLATE XIV.

*Itajahya galericulata*.—Stage III in development of plant, x 1.



PLATE XV.

Fig. 1.—*Itajahya galericulata*.—Mature plant, slender form, x 1.

Fig. 2.—*Itajahya galericulata*.—Pileus with volva cap present, x 1.

*Photographs by L. Kresfelder.*



PLATE XVI.

Fig. 1.—*Itajahya galericulata*, section through pileus, x 1.

Fig. 2.—*I. galericulata*, pileus with part of spore mass removed, x 1.

Fig. 3.—*I. galericulata*, section through pileus after removal of spore mass.

*Photographs by L. Kresfelder.*



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PLATE XVII.

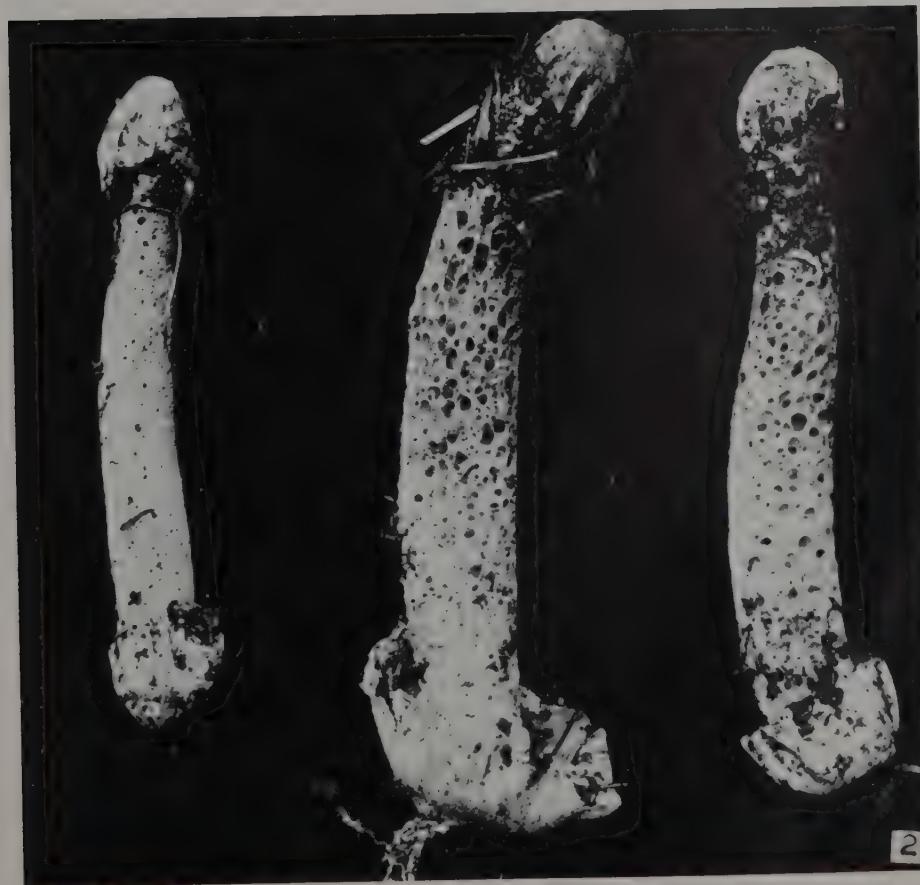
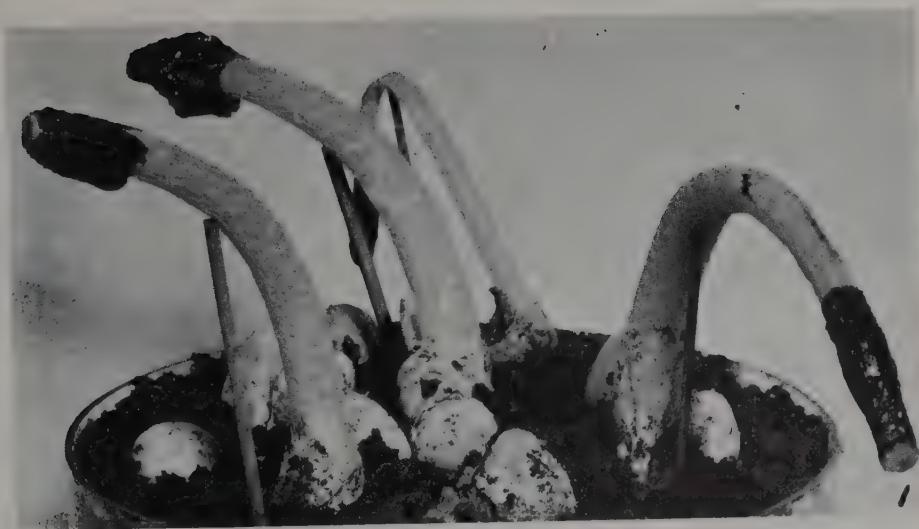
*Phallus impudicus* after Lloyd.



PLATE XVIII.

Fig. 1.—*Phallus rubicundus*, old specimens developed indoors and  
“eggs”, x 1.

Fig. 2.—*P. rubicundus*, mature plants with remains of volva on  
apex of pileus, x 1.



## PLATE XIX.

Fig. 1.—*Dictyophora indusiata*, mature plant,  $\times 1$ .

Fig. 2.—*D. indusiata*, developed indoors, showing pileus without spore mass,  $\times \frac{1}{2}$ .

Fig. 3.—*D. indusiata* after Moeller.



PLATE XX.

Fig. 1.—*Linderiella columnata* after Welwitch and Currey.  
Fig. 2.—*L. columnata* after G. H. Cunningham  
Fig. 3.—*Aseroe rubra* after G. H. Cunningham.

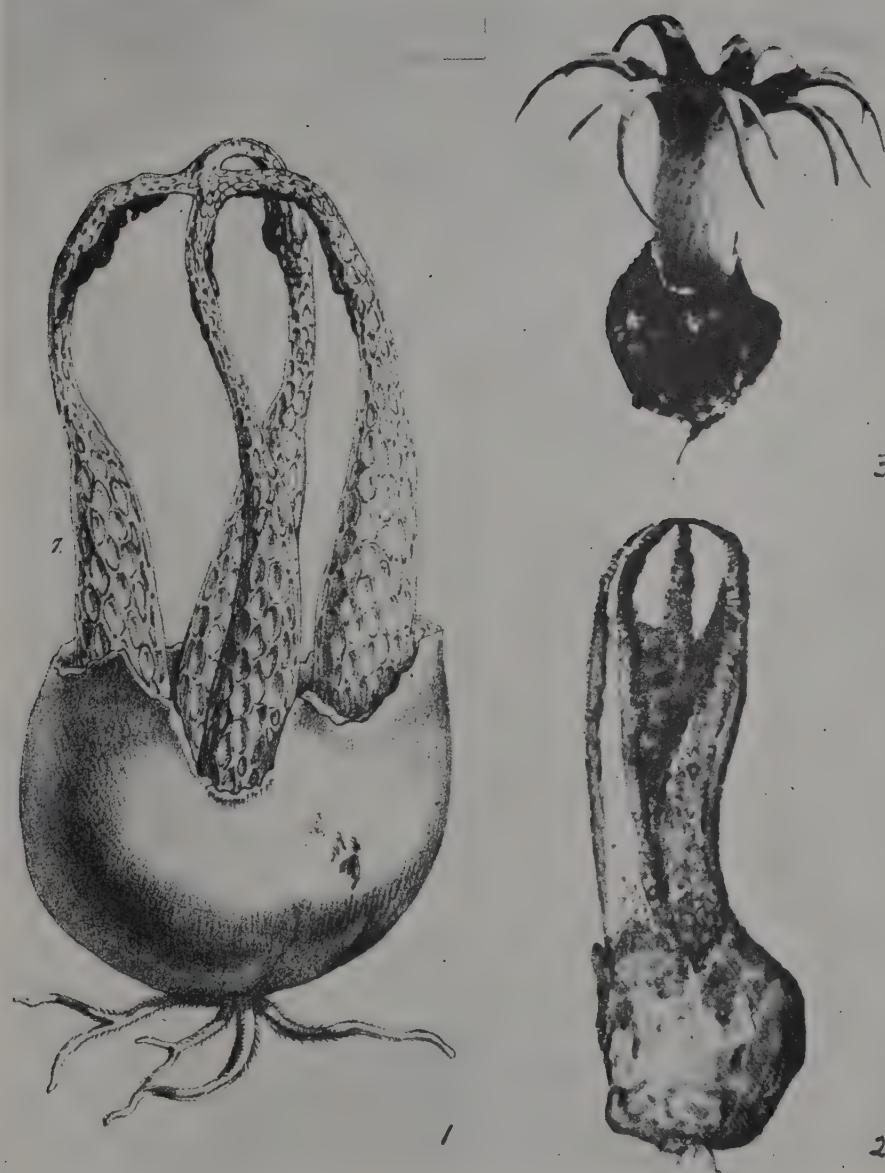


PLATE XXI.

Figs. 1 and 2.—*Anthurus Archeri*. Note external longitudina  
groove on arms, x 1.

*Photographs supplied by Miss E. L. Stephens.*

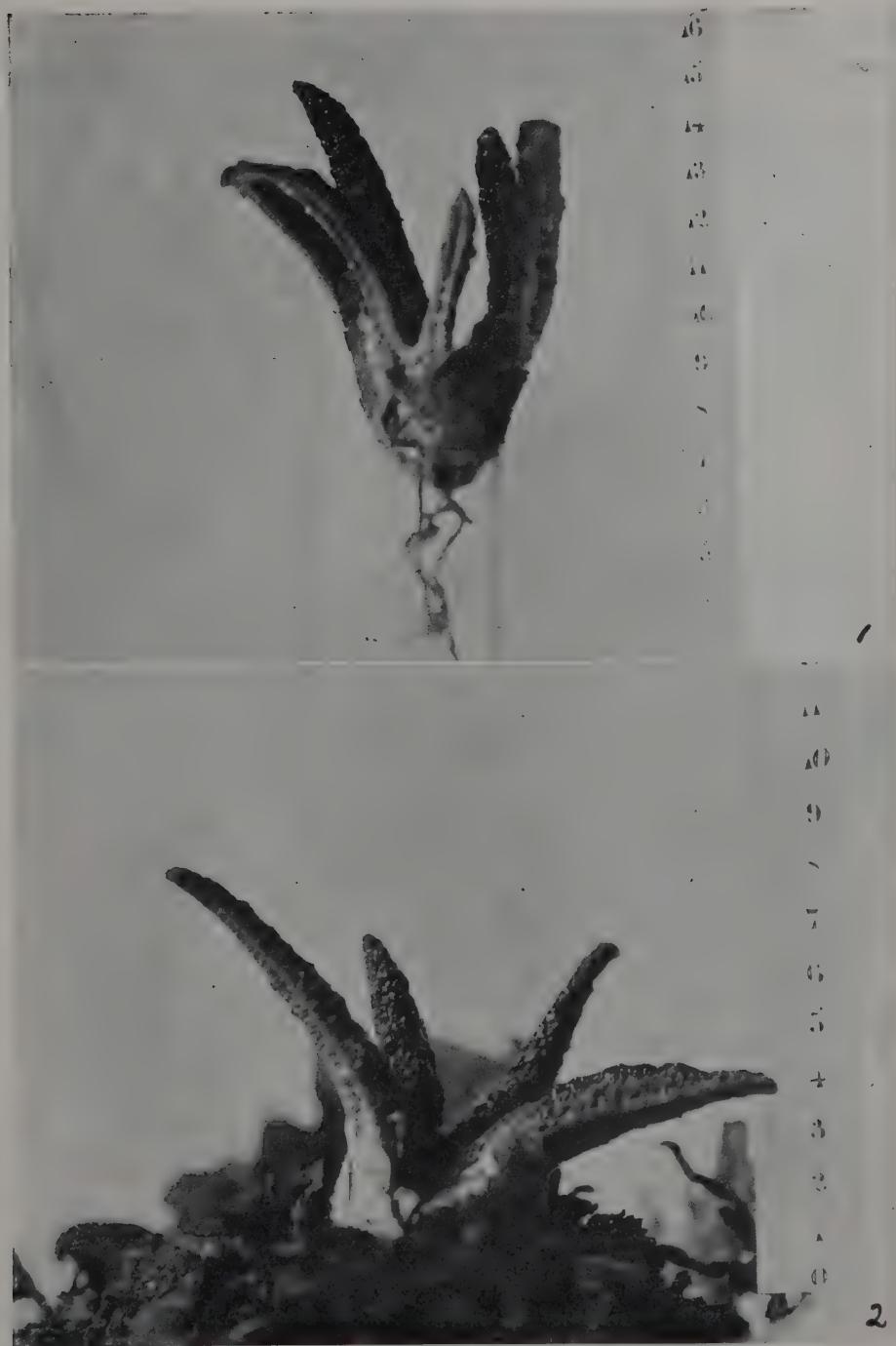


PLATE XXII.

*Lysurus Gardneri*, plants developed indoors from "eggs", x 1.



PLATE XXIII.

Fig. 1.—*Kalchbrennera corallocephala*, development of plant from  
“egg” stage.

*Photograph of sketch by Miss G. J. Lewis.*

Figs. 2 and 3.—*K. corallocephala*, mature plant.

*Photographs by I. B. Pole Evans.*

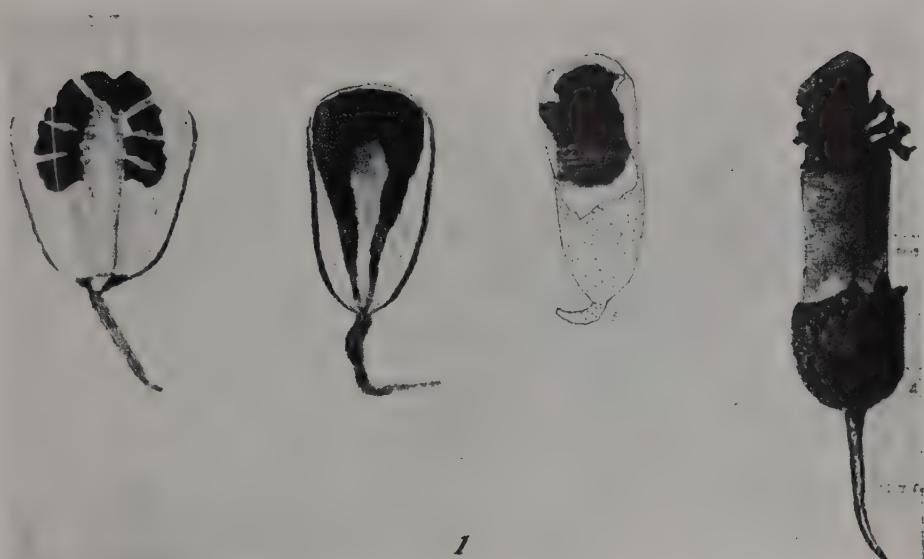


PLATE XXIV.

*Kalchbrennera corallocephala*.—Photograph of original painting  
by Kalchbrenner as *K. Tuckii*.

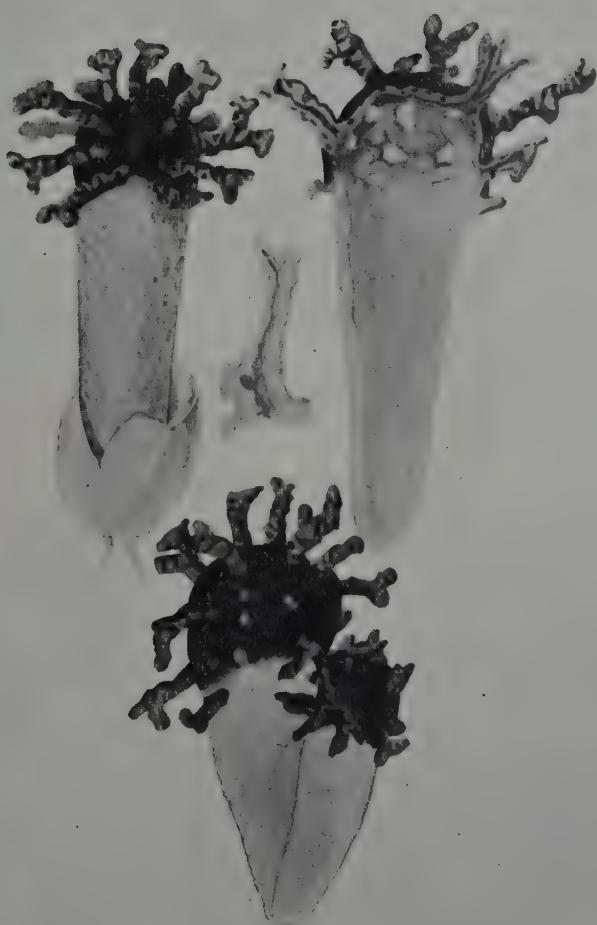


PLATE XXV.

Fig. 1.—*Clathrus gracilis*, developed indoors from “ egg ”.  
Photograph supplied by Miss E. L. Stephens.

Fig. 2. *Clathrus camerunensis* after v. d. Byl.

Fig. 3.—*Mutinus simplex* after Lloyd.

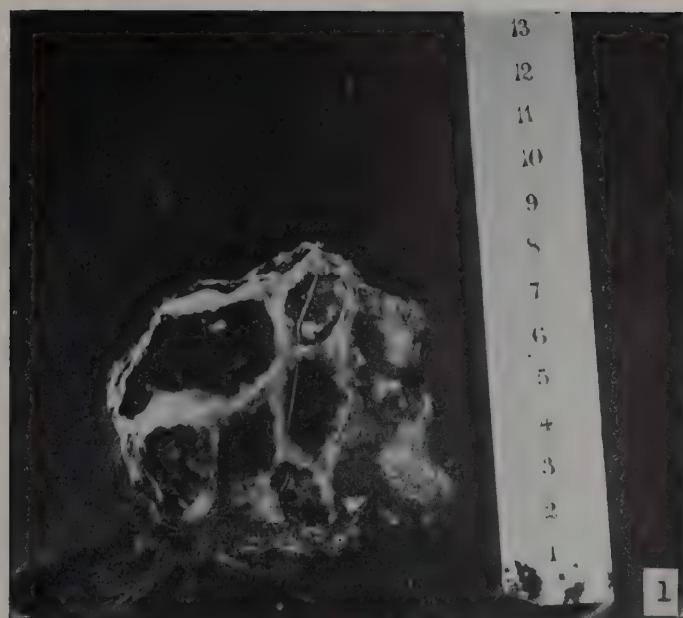


PLATE XXVI.

Fig. 1.—*Clathrella* cfr. *pseudocancellata*, dry plant, x 1.

Fig. 2.—Same, fresh plant, x 1.



PLATE XXVII.

*Clathrus* sp., x 1.

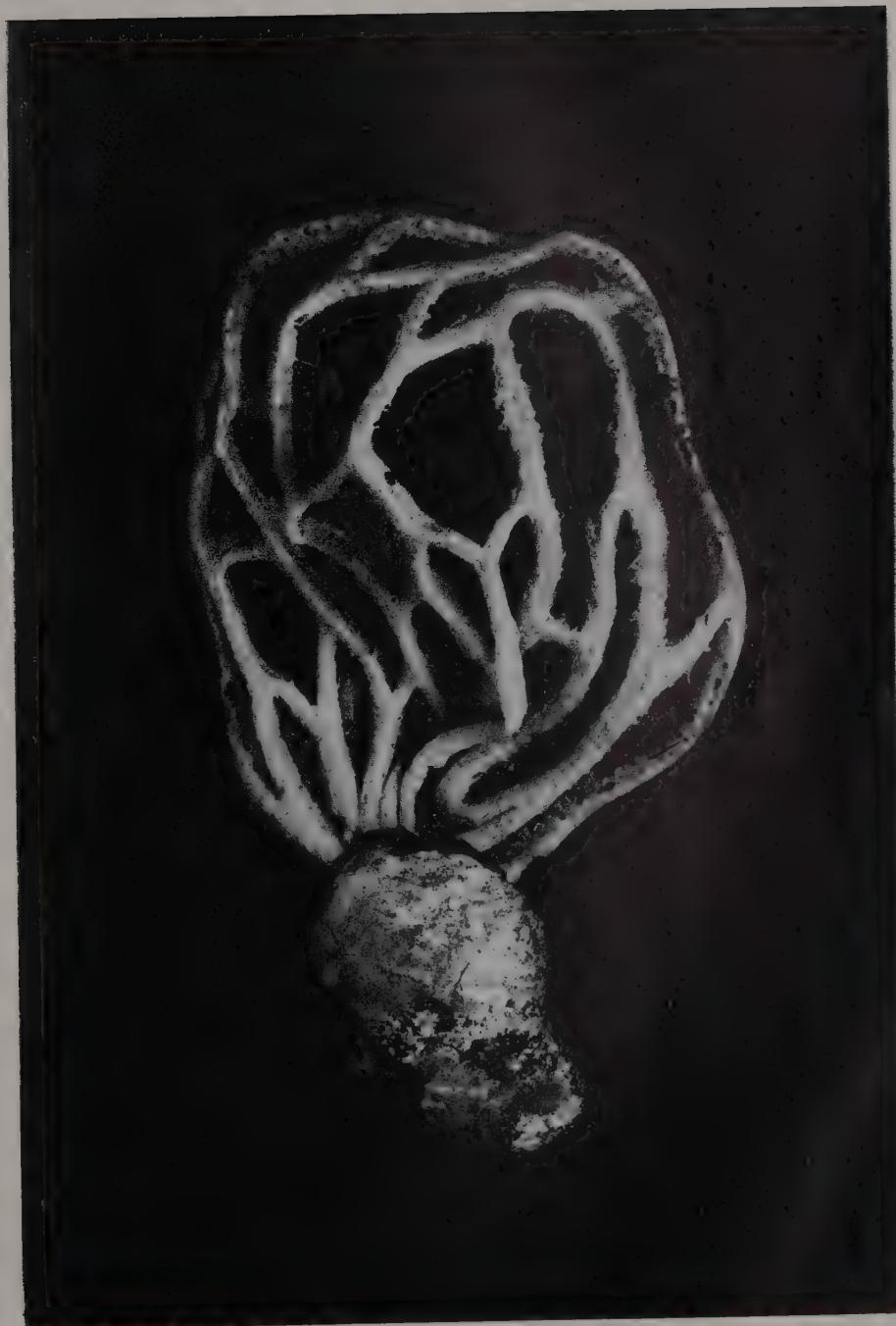


PLATE XXVIII.

Fig. 1.—*Scleroderma cepa*, x 1.

Fig. 2.—*Scleroderma verrucosum*, x 1.

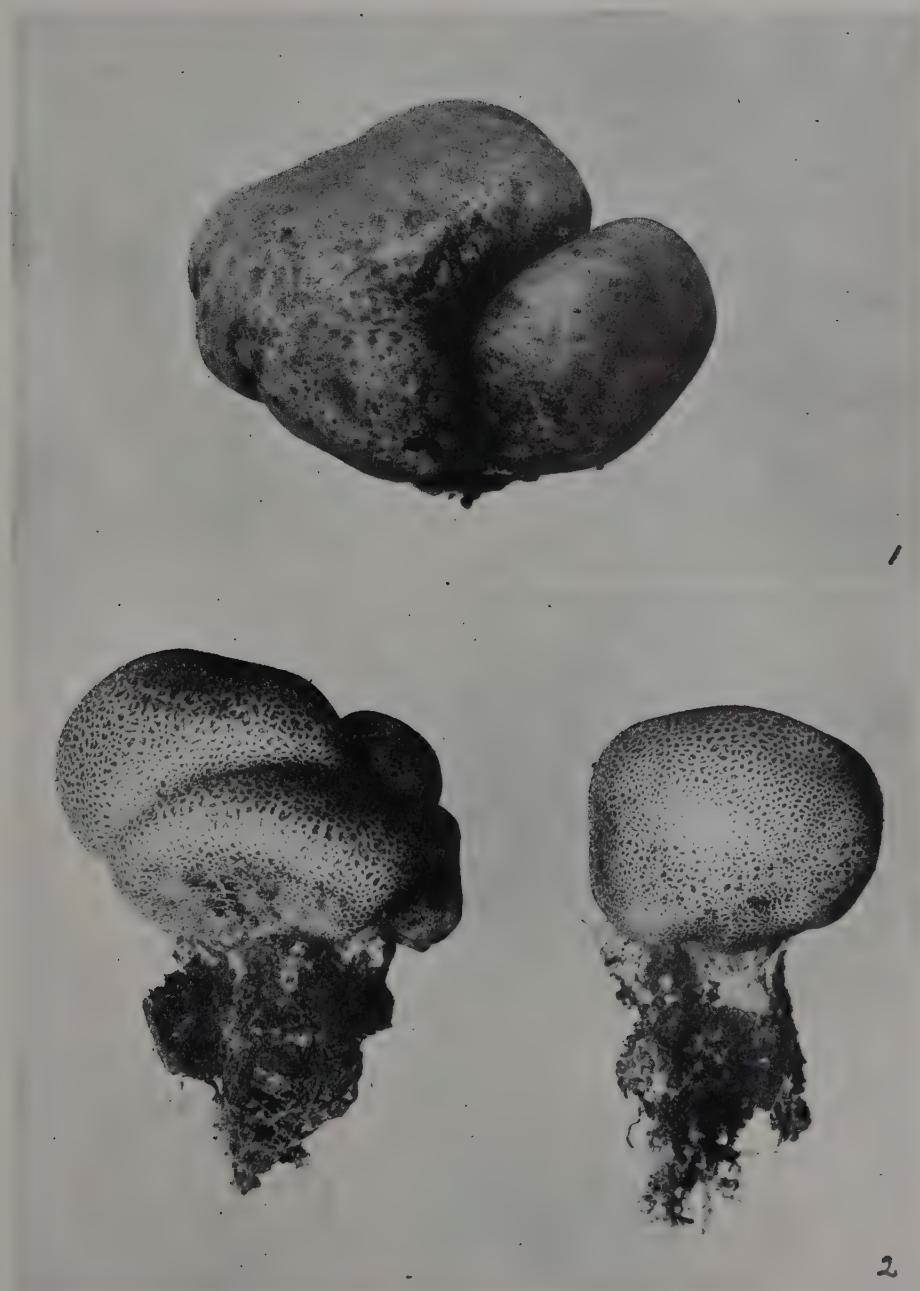


PLATE XXIX.

Fig. 1.—*Scleroderma cepa*, section, x 1.

Fig. 2.—*Scleroderma verrucosum*, section, x 1.



PLATE XXX.

Figs. 1 and 2.—*Scleroderma flavidum*, x 1.

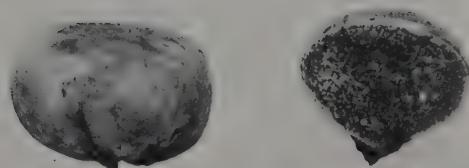


PLATE XXXI.

Fig. 1.—*Arachnion album*, after Lloyd.

Fig. 2.—*Scleroderma aurantium*, x 1.

Fig. 3.—*Scleroderma flavidum*, x 1.



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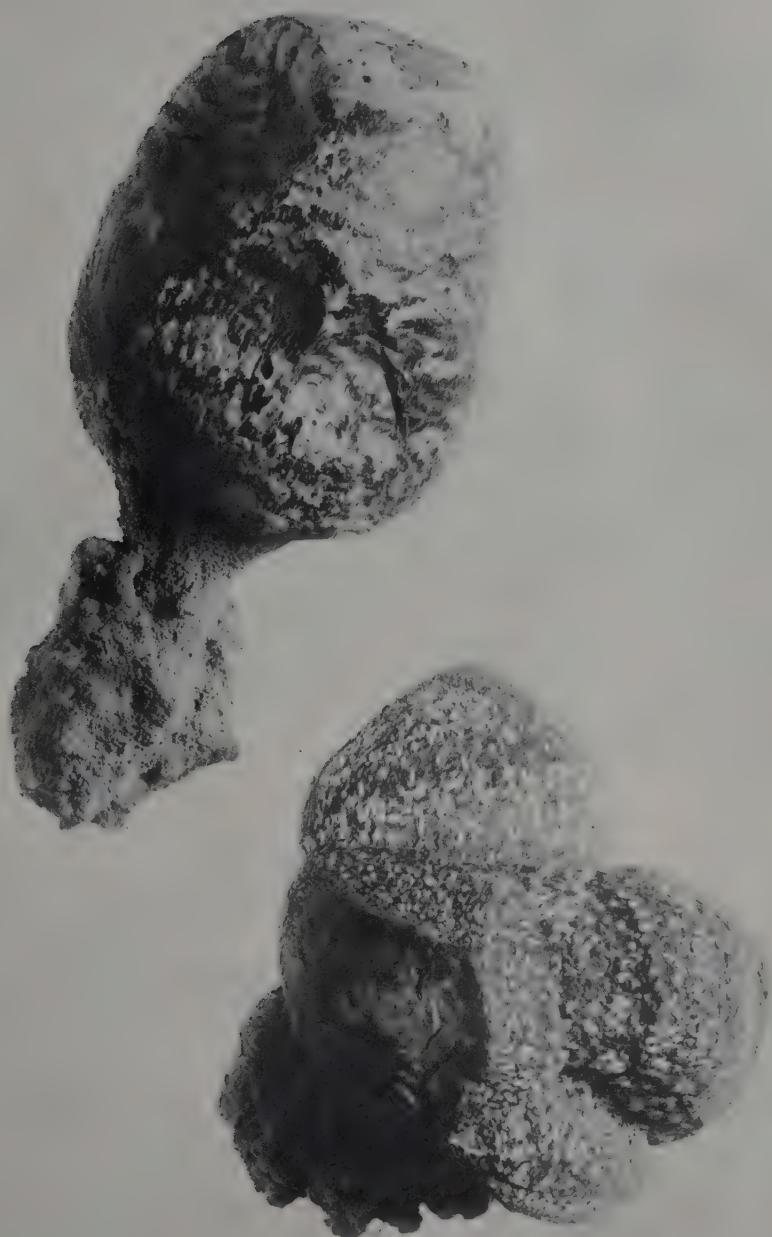


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PLATE XXXII.

Fig. 1.—*Pisolithus tinctorius*, x 1.

Fig. 2.—*P. tinctorius*, apically split showing structure of gleba, x 1



## PLATE XXXIII.

Fig. 1.—*Lycoperdon hyemale*, typical form, x 1.

Fig. 2.—*L. hyemale*, section of old plant showing sterile base and diaphragm, x 1.

Fig. 3.—*L. hyemale* showing mouth, x 1.

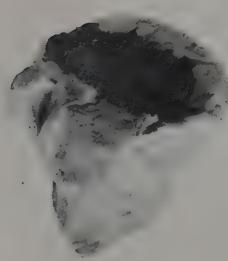
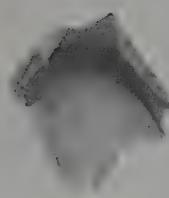
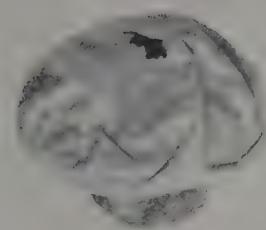


## PLATE XXXIV.

Top row.—*Lycoperdon hyemale*, unusual form in which exoperidium has completely disappeared, x 1.

Middle row.—*L. hyemale*, form with large irregular mouth, x 1.

Bottom row.—*L. hyemale*, connivent spines enlarged.

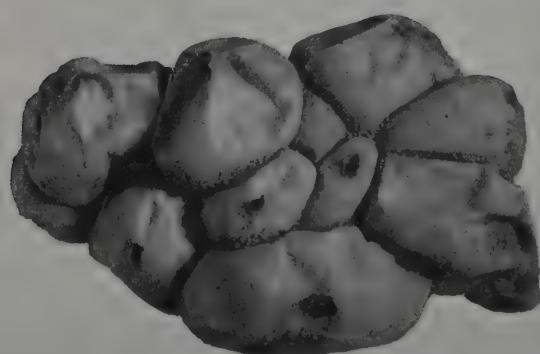


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## PLATE XXXV.

Fig. 1.—*Lycoperdon perlatum*, x 1.

Fig. 2.—*Lycoperdon djurensz*, x 1.

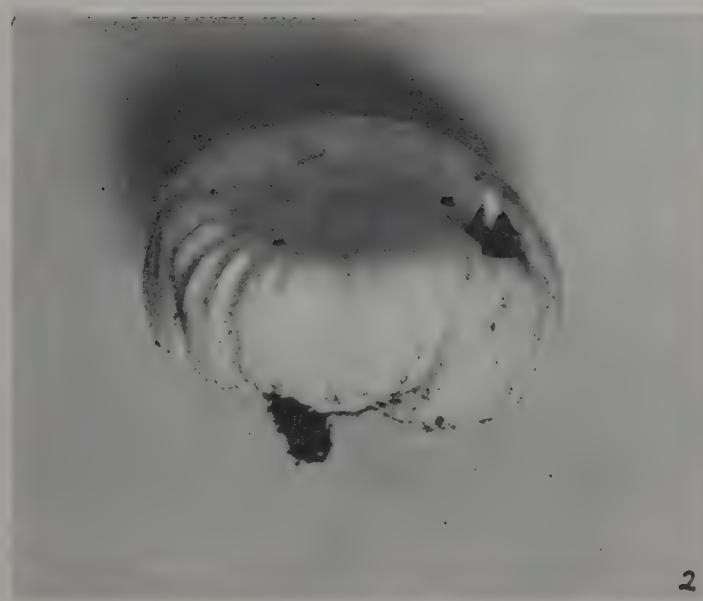


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PLATE XXXVI.

Fig. 1.—*Lycoperdon flavum*, after Massee.

Fig. 2.—*L. flavum*, fresh plant, x 1.



## PLATE XXXVII.

*Lycoperdon asperum* after Lloyd as *Bovistella aspera*.



Fig. 6.



Fig. 7.



Fig. 8.



Fig. 10.



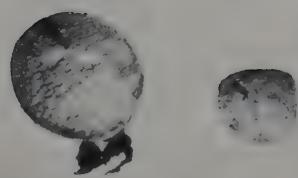
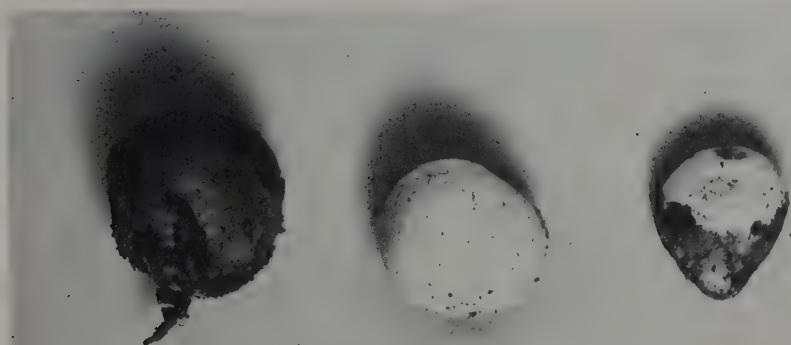
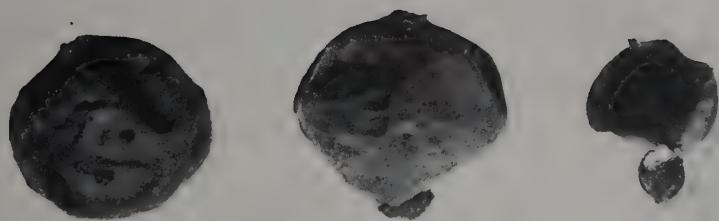
Fig. 9.

## PLATE XXXVIII.

Fig. 1.—*Lycoperdon polymorphum*, x 1.

Fig. 2.—*L. pusillum*, fresh plant, x 1.

Fig. 3.—*L. pusillum*, dried plant, x 1.



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## PLATE XXXIX.

Fig. 1.—*Lycoperdon Gunnii*, x 1.

Fig. 2.—*L. Qudenii*, x 1.

Fig. 3.—*L. Duthiei*, x 1.

Fig. 4.—*Bovista umbrina*, pressed specimens, x 1.

Fig. 5.—*Calvatia incerta*, x 1.

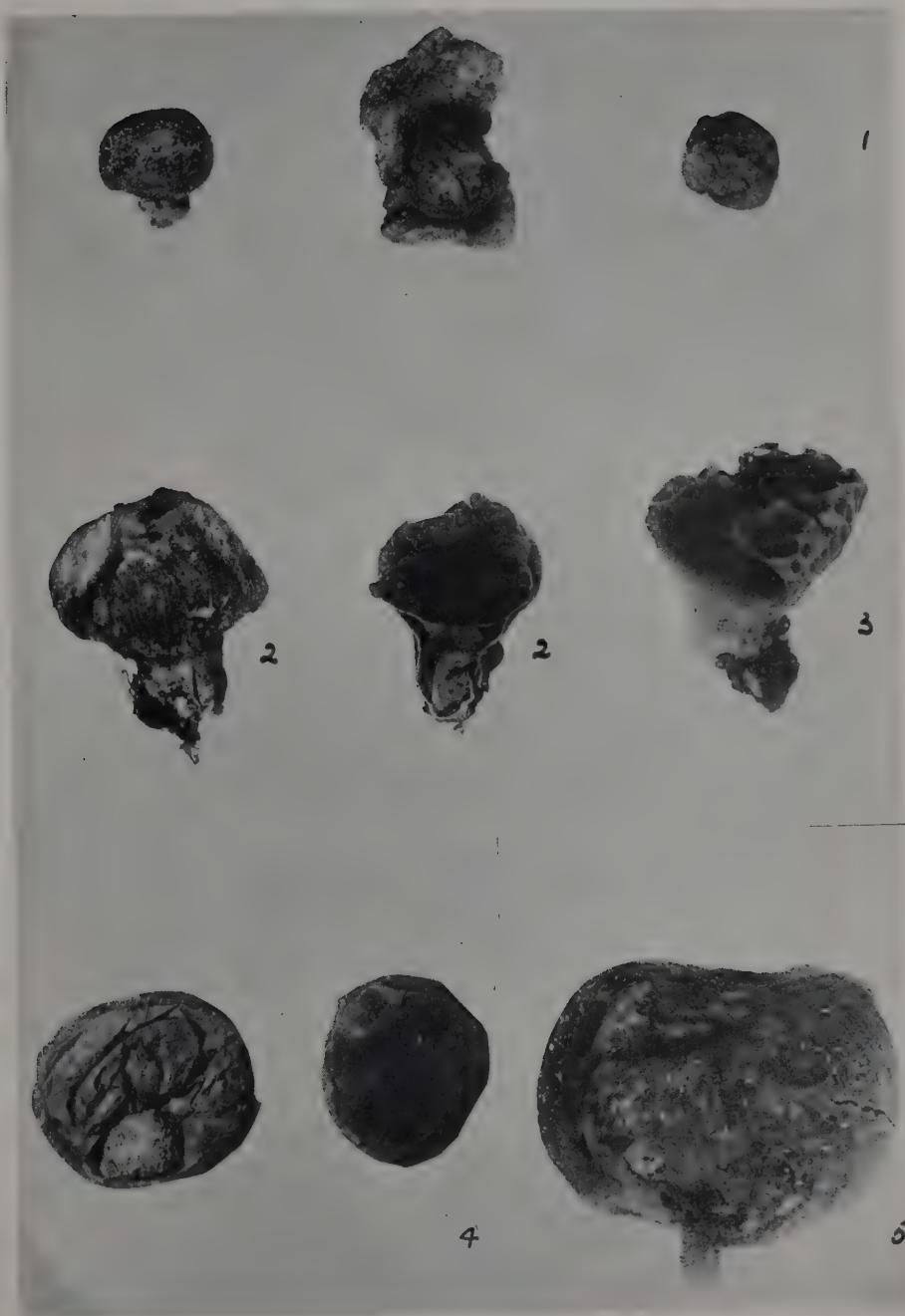


PLATE XL.

Fig. 1.—*Lycoperdon capense* after Massee.

Fig. 2.—*L. bicolor* after Massee.

Fig. 3.—*L. asperimum* after Massee.



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PLATE XLI.

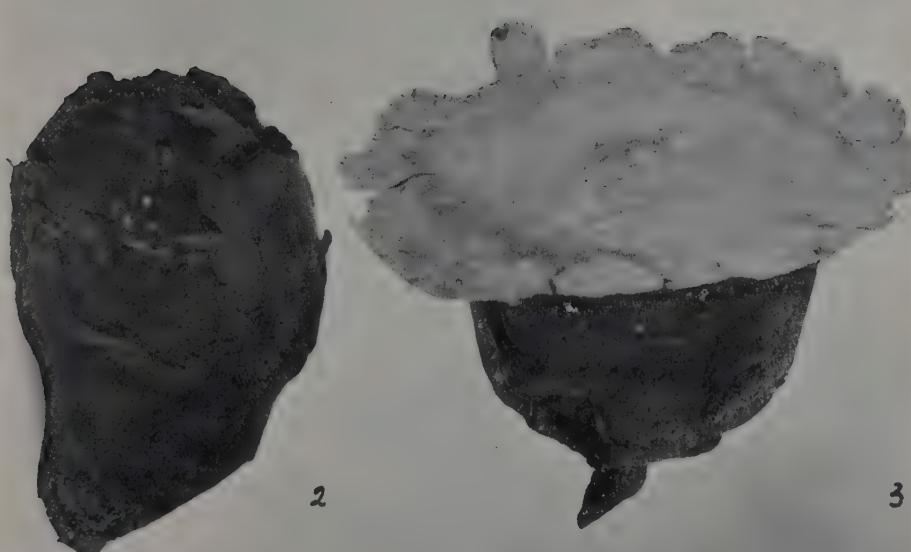
Fig. 1.—*Calvatia candida*, x 1.

Fig. 2.—*C. lilacina*, x 1.

Fig. 3.—*C. lilacina*, after gleba has disappeared, x 1.



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PLATE XLII.

Fig. 1.—*Calvatia caelata*, x 1.

*Photograph by I. B. Pole Evans.*

Fig. 2.—*C. lepidophora* with warty exoperidium, x 1.

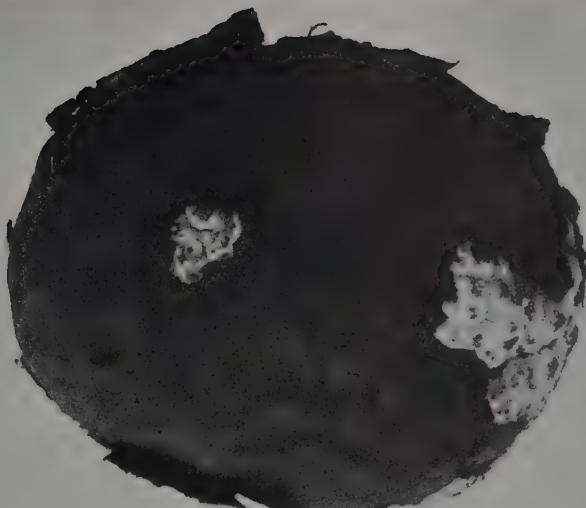


PLATE XLIII.

Fig. 1.—*Calvatia lepidophora* with granular exoperidium, x 1.



PLATE XLIV.

Fig. 1.—*Calvatia gigantea*, x 1.

Fig. 2.—*C. pachyderma*, x 1.



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PLATE XLV.

*Lanophila Wahlbergii*, x 1.

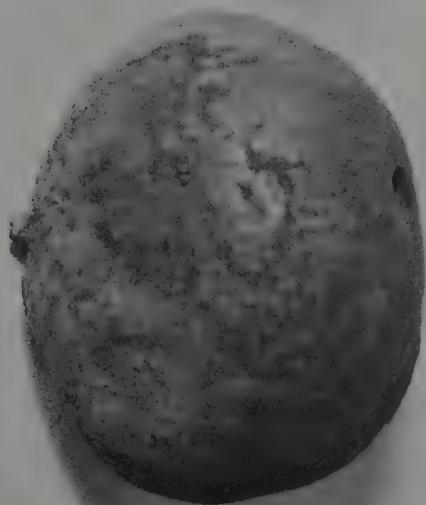


PLATE XLVI.

*Broomeia congregata*, taken from base of *Acacia* tree.



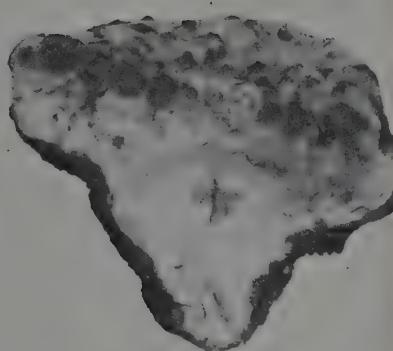
## PLATE XLVII.

Fig. 1.—*Broomeia congregata* with remains of universal veil, x 1.

Fig. 2.—*B. congregata*, vertical section showing thick stroma, x 1.

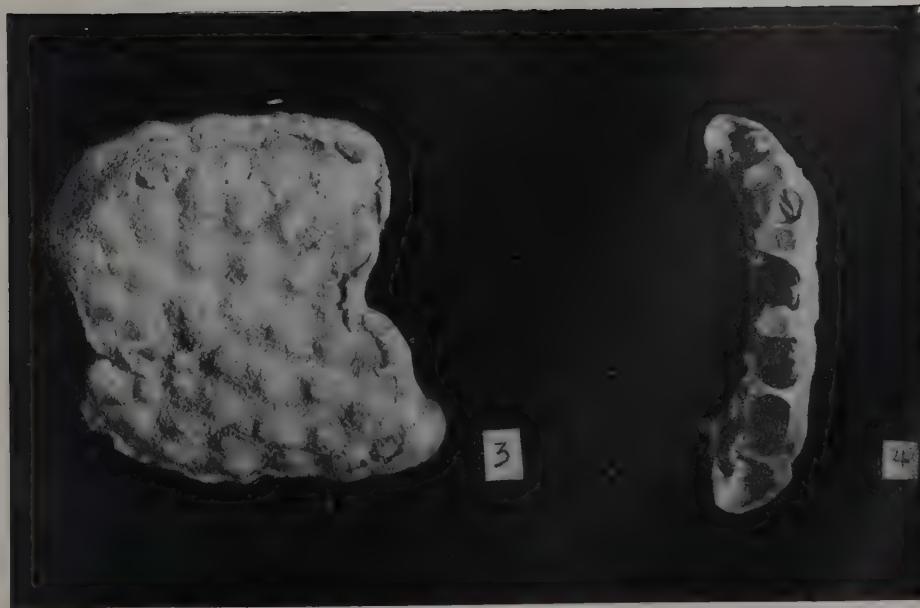
Fig. 3.—*B. ellipsospora*, underside, x 1.

Fig. 4.—*B. ellipsospora*, vertical section showing thin stroma, x 1.



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PLATE XLVIII.

Fig. 1.—*Diplocystis Wrightii*. Note peridia separated by individual exoperidial walls,  $\times 1$ .

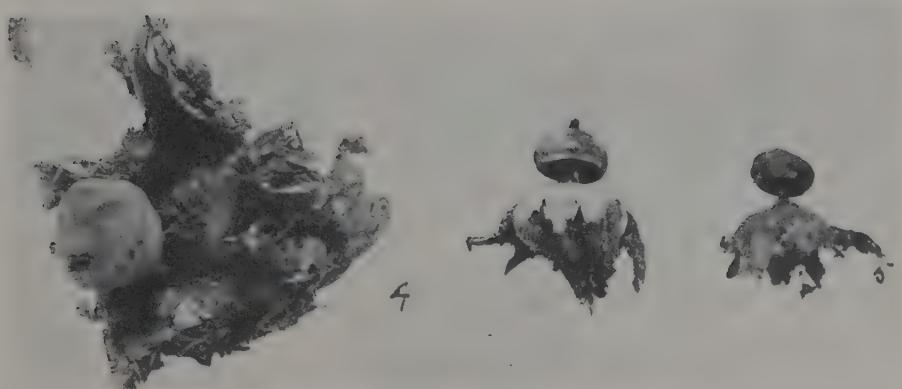
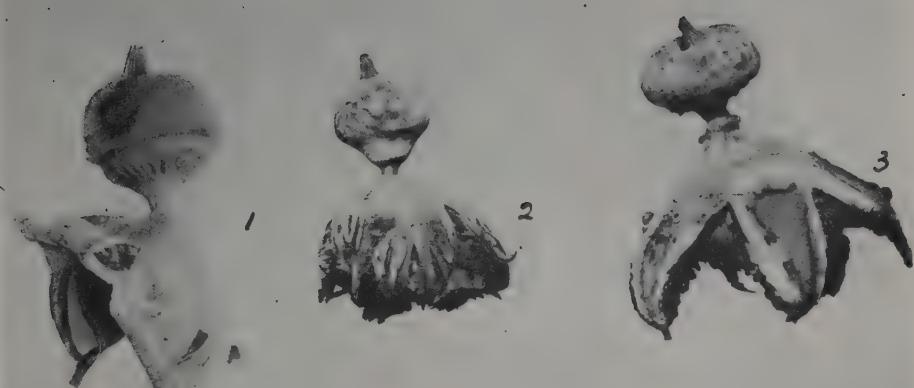
Fig. 2.—*Broomeia congregata*.—Note peridia separated by common alveolar walls,  $\times 1$ .



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## PLATE XLIX.

Fig. 1.—*Geastrum pectinatum* with grooved base, x 1.  
Fig. 2.—*G. pectinatum* with smooth base, x 1.  
Fig. 3.—*G. pectinatum* with collar on pedicel, x 1.  
Fig. 4.—*G. pectinatum* with incurved exoperidium, x 1.  
Fig. 5.—*G. Bryanti*.  
Fig. 6.—*G. nanum*.

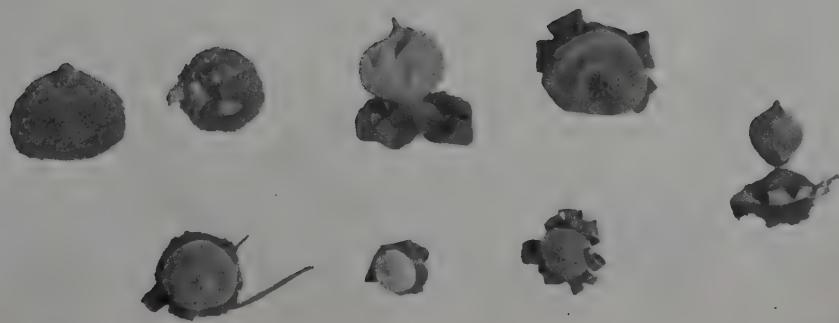


## PLATE I.

Fig. 1.—*Geastrum quadrifidum*, x 1.  
Fig. 2.—*G. nanum*, x 1.  
Fig. 3.—*G. campestre*, x 1.



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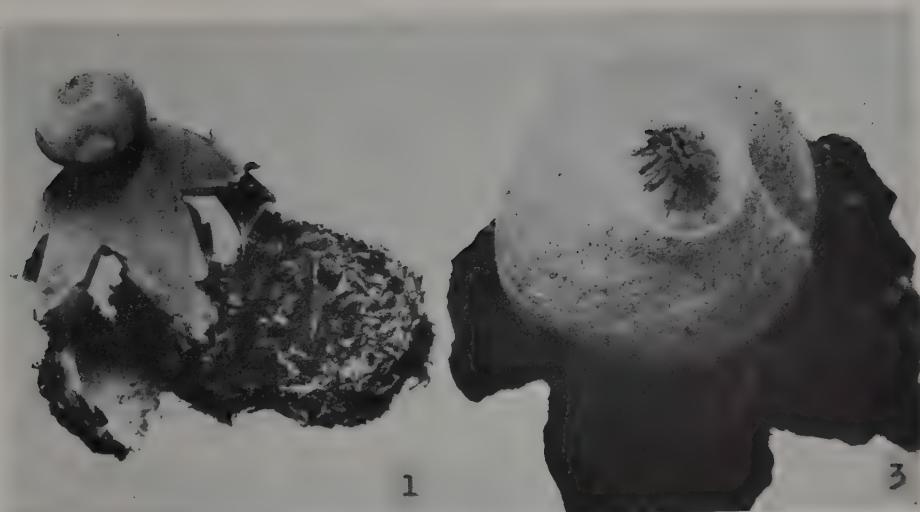
## PLATE LI.

Fig. 1. *Geastrum dissimile*, x 1.

Fig. 2.—*G. dissimile* with mouth enlarged.

Fig. 3. *G. quadrifidum* with mouth enlarged.

Fig. 4.—*G. fornicatum* with mouth enlarged.



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## PLATE LII.

Top row.—*Geastrum minimum*, after Lloyd as “*Geaster granulosus*”.

Second and Third rows.—*G. minimum*.

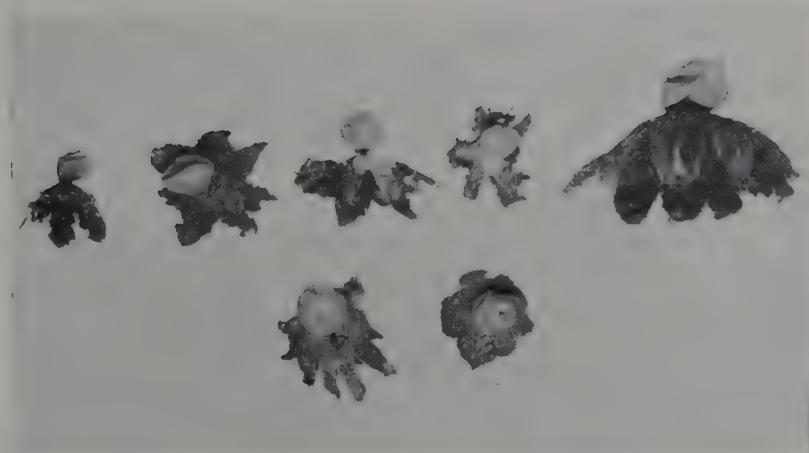
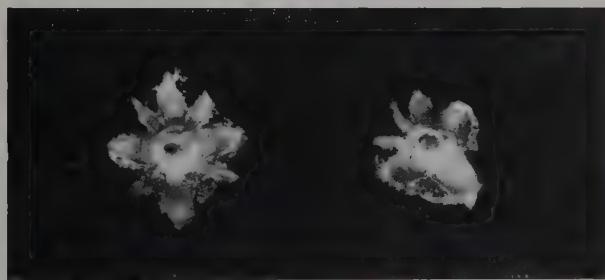
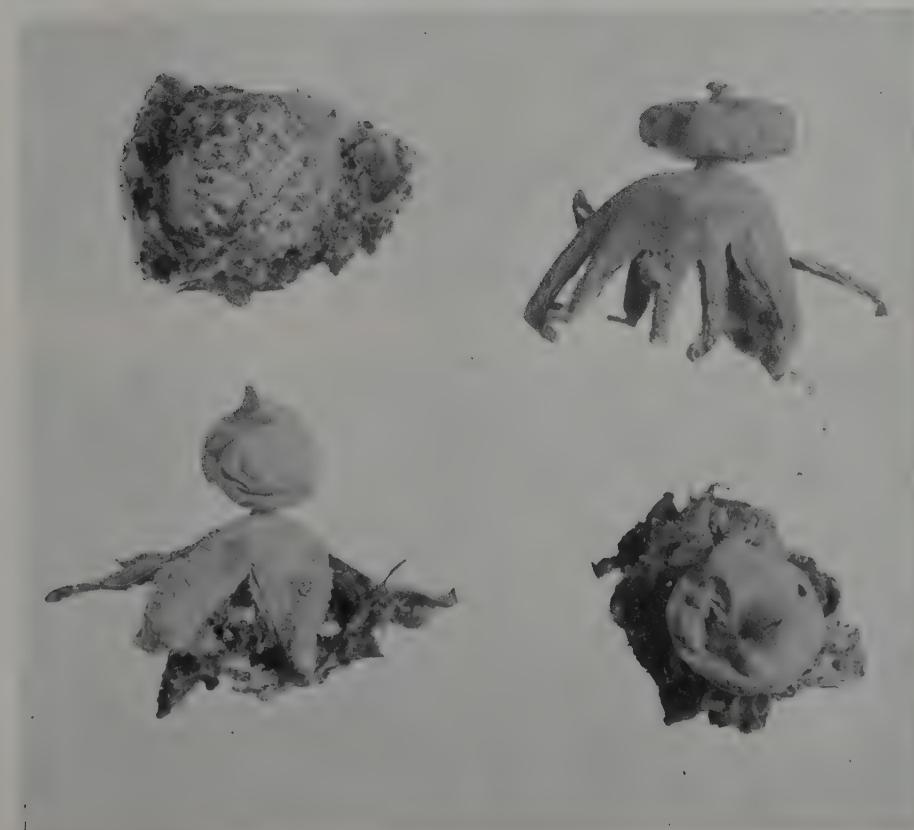


PLATE LIII.

Top row.—*Geastrum limbatum*, usual form,  $\times 1$ .

Middle row.—*G. limbatum*, unexpanded plant and egg,  $\times 1$ .

Bottom row.—*G. limbatum*, form with ellipsoid mouth,  $\times 1$ .



## PLATE LIV.

Top row.—*Geastrum triplex*, underside showing typical mycelial layer,  $\times 1$ .

Middle row.—*G. triplex*, small type of plant with acuminate pointed unexpanded plants.

Bottom row.—*G. triplex*.—Two figures on left, photographs of MacOwan No. 1124 specimens as *Geaster fimbriatus*. Figures on right, photograph of MacOwan's specimen No. 1236 as *Geaster capensis*.

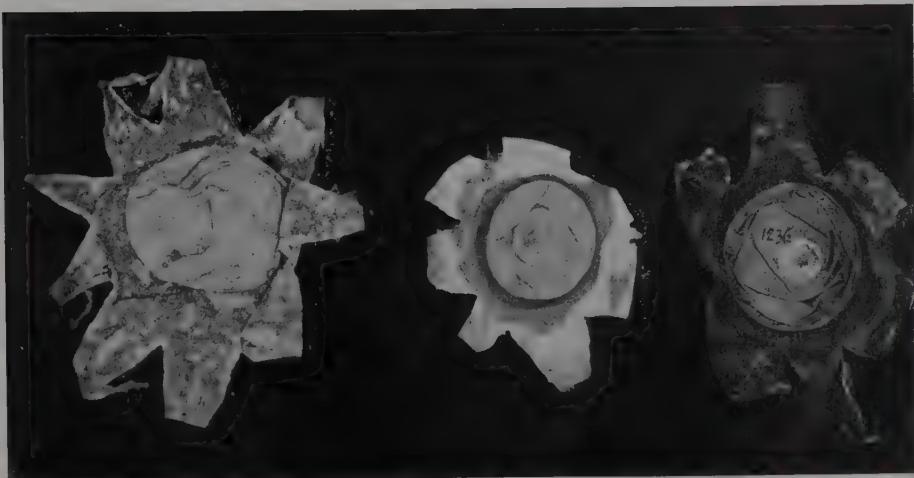
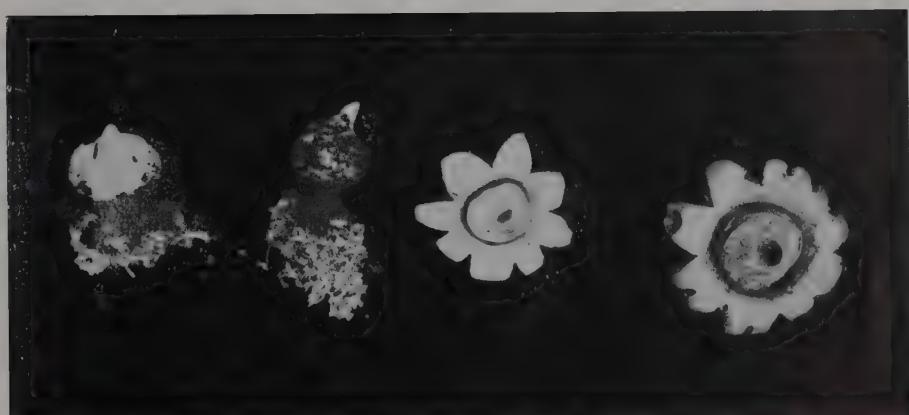


PLATE LV.

*Gastrum triplex*, fresh plants, x 1.

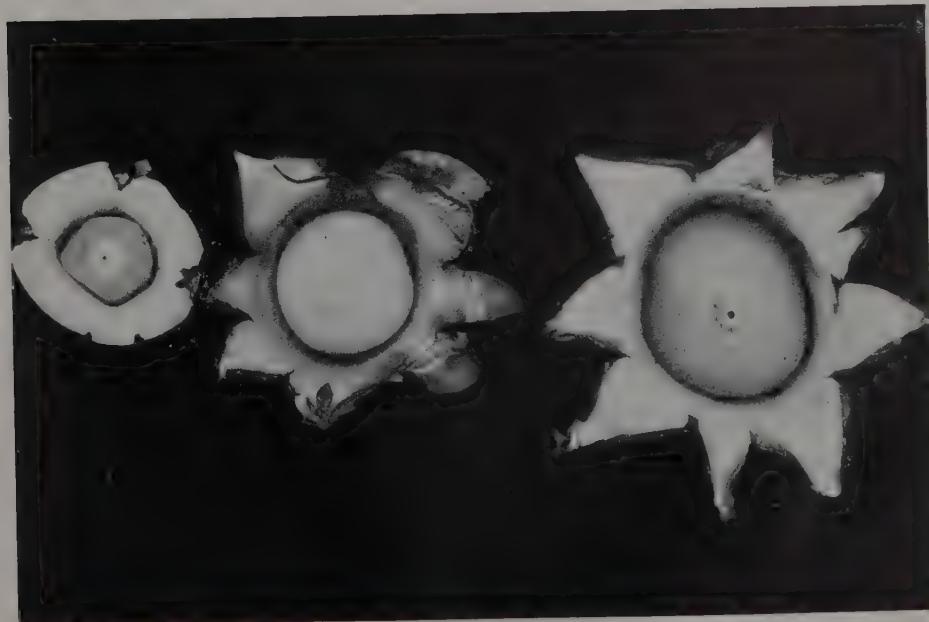
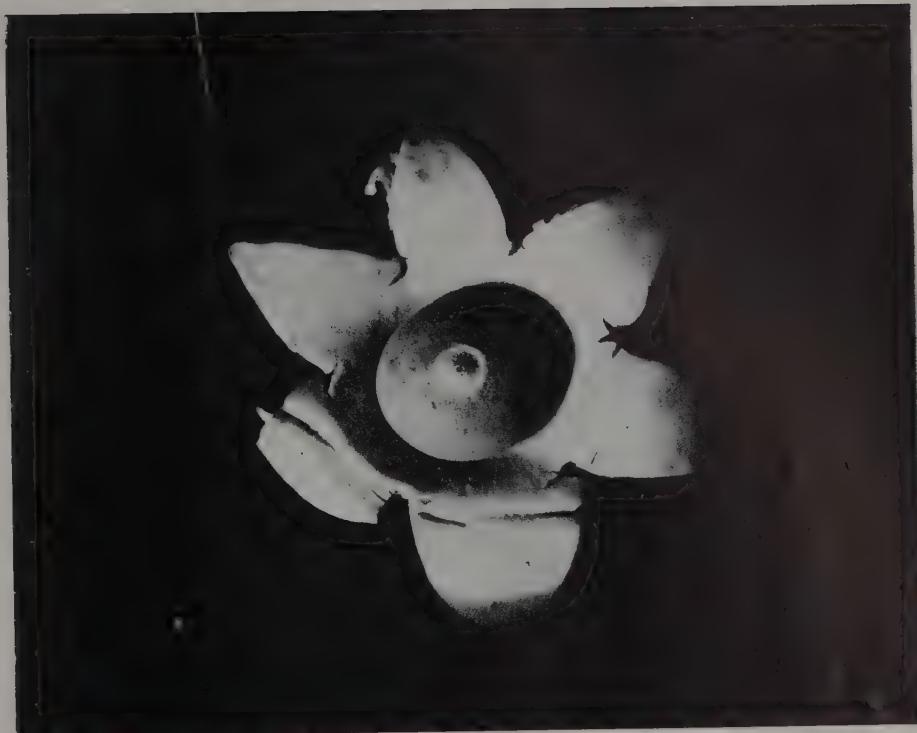


PLATE LVI.

Fig. 1.—*Geastrum saccatum*, typical plants with subglobose and pointed unexpanded plants,  $\times 1$ .

Fig. 2.—*G. saccatum*, large type,  $\times 1$ .

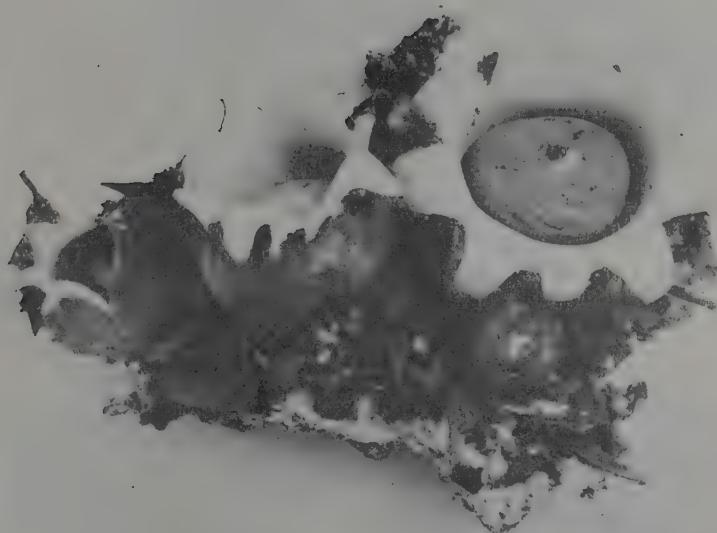
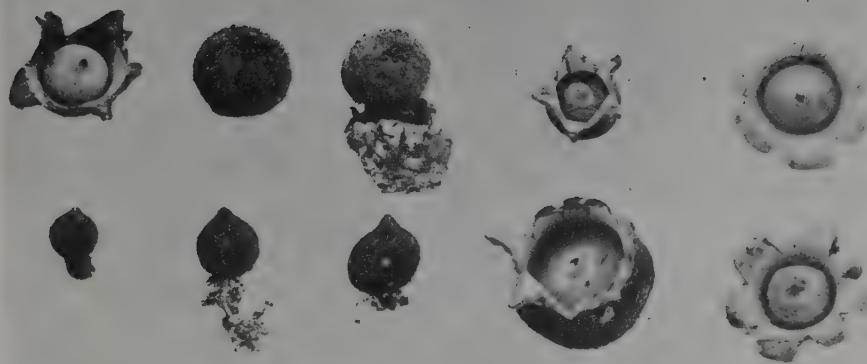


PLATE LVII.

Fig. 1.—*Geastrum mirabile*, x 1.

Fig. 2.—*Geastrum velutinum*, x 1.

Fig. 3.—*Geastrum arenarium*, x 1.



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PLATE LVIII.

*Geastrum fornicatum*, with and without the mycelial cup, x 1.



## PLATE LIX.

Upper row.—*Geastrum floriforme*, x 1.

Lower row.—*G. Hieronymi*, x 1.

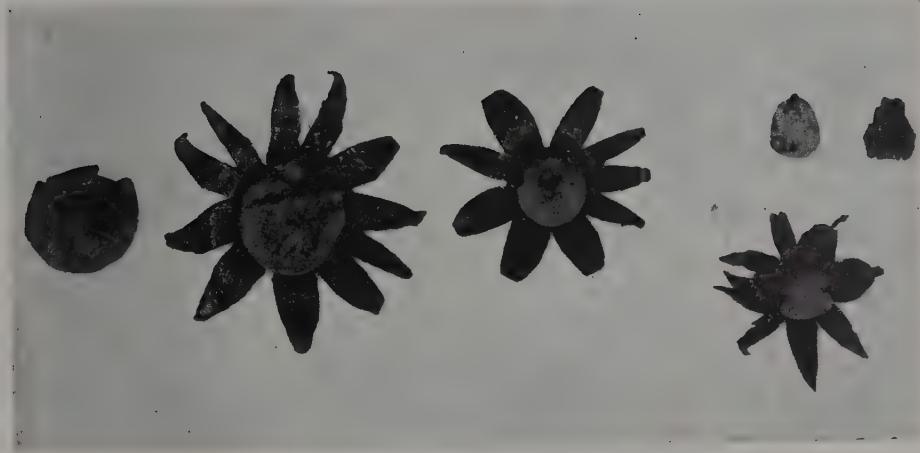
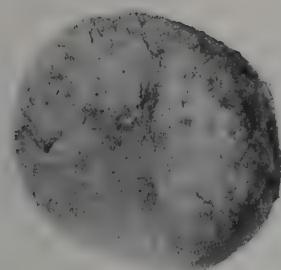


PLATE LX.

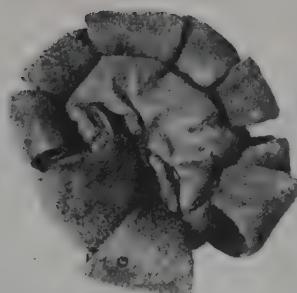
Fig. 1.—*Geastrum hygrometricum*, unexpanded plant, x 1.

Fig. 2.—*G. hygrometricum* in dry weather, x 1.

Figs. 3 and 4.—*G. hygrometricum* in wet weather, x 1.



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## PLATE LXI.

Fig. 1.—“*Geaster MacOwani*” after Lloyd.

Fig. 2.—“*Geaster calceus*” after Lloyd.

Figs. 3 and 4.—*Myriostoma coliforme*, x 1.



PLATE LXII.

Left.—*Geasteropsis Conrathi*, underside of young plant.

Right.—*G. Conrathi* upper view. Note membranous endoperidium and columella from which gleba has partly disappeared.

*Photograph by J. P. H. Acocks.*

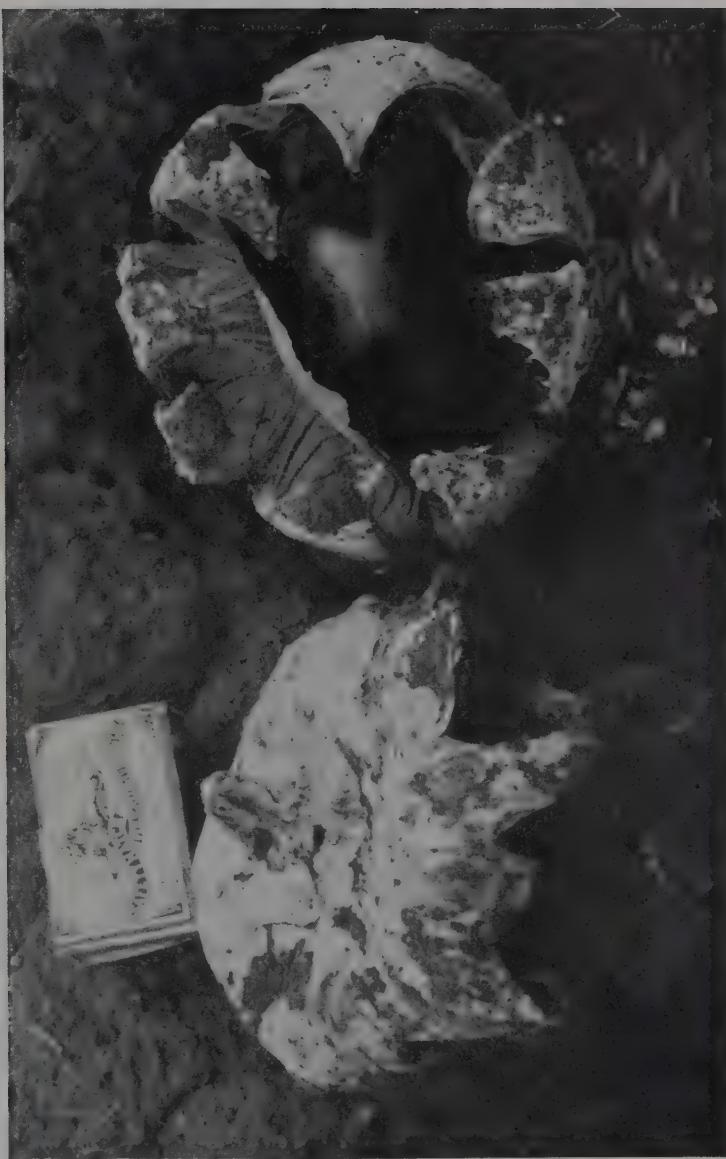


PLATE LXIII.

Fig. 1.—*Geasteropsis Conrathi*, section through immature plant, x 1.

Fig. 2.—*G. Conrathi*, mature plant. Note torn endoperidium, x1



2

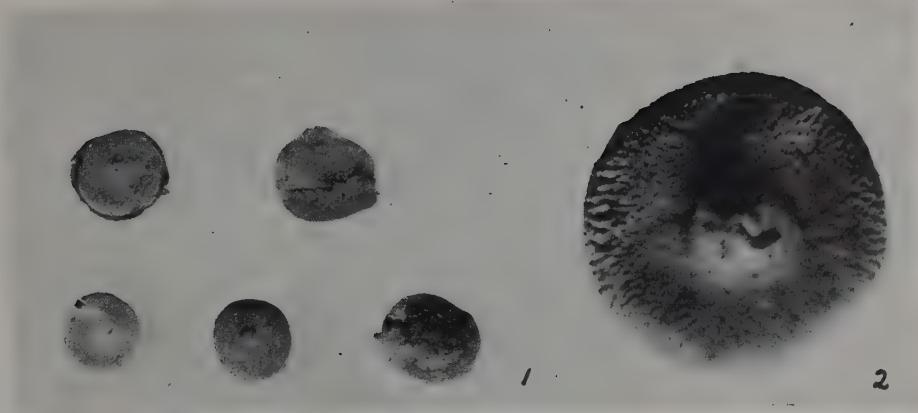
## PLATE LXIV.

Fig. 1.—*Disciseda candida*, x 1.

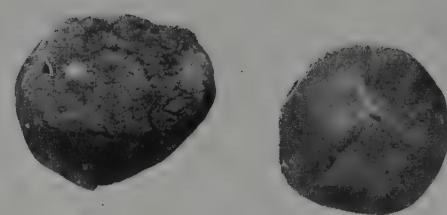
Fig. 2.—*D. candida*, enlargement of upper surface.

Fig. 3.—*D. pedicellata*, x 1.

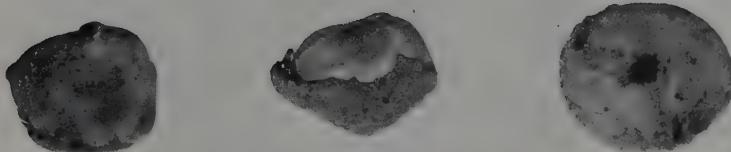
Fig. 4.—*D. verrucosa*, x 1.



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PLATE LXV.

*Mycenastrum corium*, expanding plant, x 1.

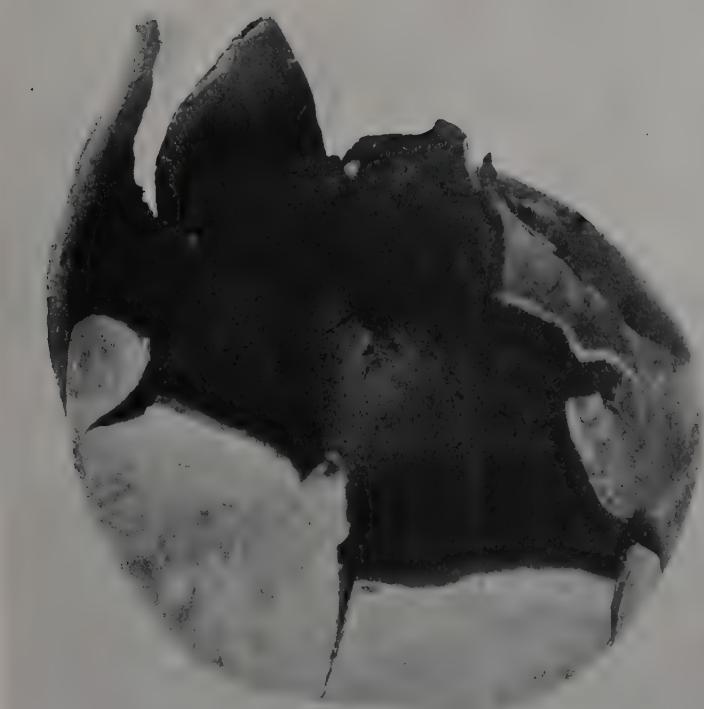


PLATE LXVI.

Fig. 1.—*Tulostoma albicans*, x 1.

Fig. 2.—*T. cyclophorum*, x 1.

Fig. 3.—*T. purpusii*, x 1.



PLATE LXVII.

Fig. 1.—*Tulostoma australianum*, x 1.

Fig. 2.—*T. transvaalii*, x 1.

Fig. 3.—*T. bonianum*, x 1.



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PLATE LXVIII.

*Tulostoma ? albicans*, x 1.

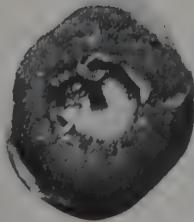


PLATE LXIX.

*Batarrea Steveni*, x 1.



PLATE LXX.

Fig. 1.—*Batarrea Diguei* before dehiscence, x 1.

Fig. 2.—*Batarrea Steveni* after disappearance of gleba, x 1.



PLATE LXXI.

Fig. 1.—*Phellorina inquinans*, x 1.

Fig. 2.—*P. inquinans* vertical section showing gleba seated on expanded apex of stem, x 1.



PLATE LXXII.

Fig. 2.—*Phellorina strobilina*, dried plant, x 1.

Fig. 2.—*P. strobilina* with portion of exoperidium and gleba removed,  
x 1.



PLATE LXXIII.

*Chlamydopus Meyenianus*, x 1.



PLATE LXXIV.

*Podaxis pistillaris* growing on "antheap", x 1.



PLATE LXXV.

*Podaxis pistillaris* on red gravel.



PLATE LXXVI.

Fig. 1.—*Podaxis pistillaris* in natural habitat.

Fig. 2.—*P. pistillaris*, vertical section showing percurrent columella,  
x 1.



## PLATE LXXVII.

Top row.—*Crucibulum vulgare*, x 1.

Second row.—*Cyathus Hookeri*, x 1.

Third row.—*C. microsporus*, x 1.

Fourth row: Left.—*C. Montagnei* after Lloyd.

Right.—*C. Berkeleyanus* after Lloyd.



## PLATE LXXVIII.

First row.—*Cyathus olla*, x 1.

Second row.—*Cyathus stercoreus*, usual and *Leseurii* form, x 1.

Third row.—*Cyathus pallidus*, x 1.

Fourth row.—*C. Poeppigii*, x 1.

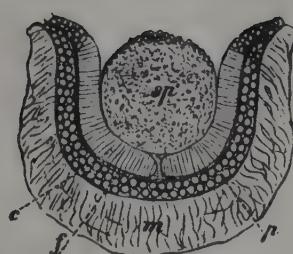
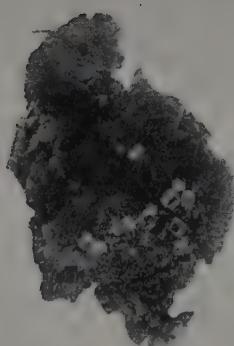


PLATE LXXIX.

Fig. 1.—*Sphaerobolus stellatus* on manure, x 1.

Fig. 2.—*S. stellatus*, diagrammatic median section through mature fruit-body after opening stellately and just before discharge of the gleba, after Buller.

Fig. 3.—*S. stellatus*, culture on horse dung, x 1 1/3. After Buller.



2



3



Synonyms are shown in italics. Page numbers in heavy type indicate the main reference.

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